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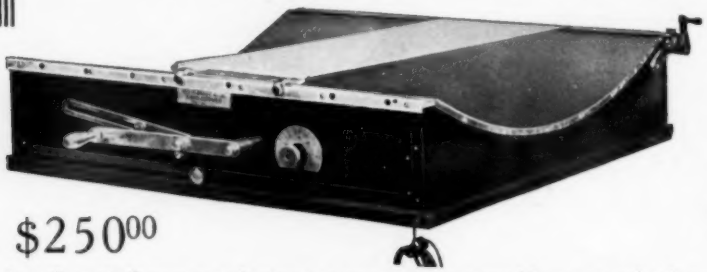

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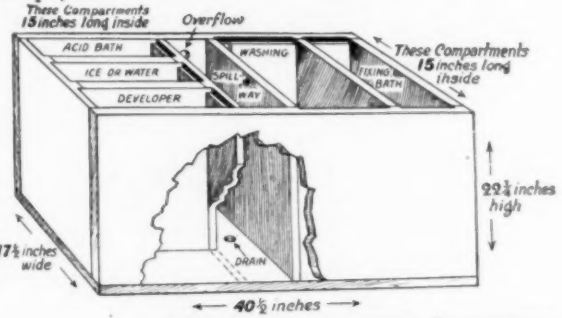

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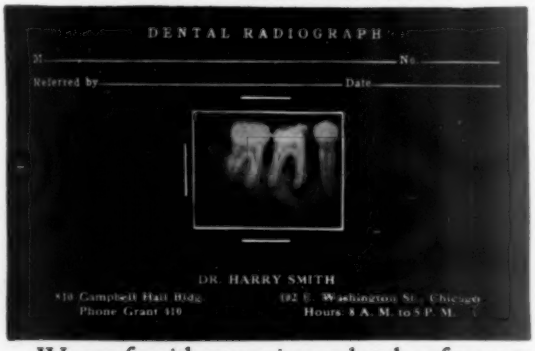

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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. XIII APRIL, 1925 No. 4

RELATION BETWEEN PHYSIOLOGICAL DOMINANCE AND THE BIOLOGICAL EFFECTS OF RAYS*

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BOSTON, MASSACHUSETTS

THE result of investigation on the relation between physiological dominance and the biological effects of rays is of peculiar interest to the clinician because of its bearing on the rationale of certain practices in the treatment of cancer, especially those based on the fact that cancer tissues are more susceptible to the influence of rays than are normal tissues. That a high metabolic rate and susceptibility are correlated is quite generally accepted as a biological fact.

The experiments which I am about to describe form part of a much more extended investigation concerning the basis of individuality in organisms. This broader problem, the basis of individuality, is also of peculiar interest to the clinician, or should be, it seems to me, especially to clinicians who are interested in the treatment of cancer, because, in one sense, we will have to think of cancer as a mass of tissue which is physiologically isolated from the individualization of the organism as a whole; that is, that the cancerous tissues have escaped from the control of the rest of the organism. The relation of a cancer to the organism as a whole is comparable to that of a parasite to its host.

Stimulation gradients, metabolic gradients, physiological dominance and physiological isolation are characteristic of all living organisms, including both animals and plants. By suitable methods of experimentation they may be demonstrated in the single-celled protozoa and protophyta, in the metazoa and metaphyta, in the colonial organizations of both animals and plants, and in the social organization of the higher vertebrates, including man.

While the terms stimulation gradients, metabolic gradients, physiological dominance and physiological isolation may be familiar to you, in order that I may more clearly point out the significance of the experiments to be described in this paper the following concrete illustrations will explain the manner in which these terms are used.

STIMULATION GRADIENTS

Figure 1 is from a book by Child on the "Basis of Individuality in Organisms" published by the University of Chicago Press, 1915. It is a diagrammatic representation of a stimulated ameba after a period of complete rest. All pseudopods have been withdrawn and the protoplasm has contracted into a sphere. In the resting condition all stimuli are supposed to have disappeared so that the state of metabolism is homogeneous throughout.

Now, suppose that the ameba is irritated at the point *a*. As a result of this, stimulation will be increased at this point but the stimulus is propagated throughout the mass of protoplasm; and unlike the pro-

* From the Laboratories of Biophysics, Harvard University. Read at the Twenty-fifth Annual Meeting, AMERICAN ROENTGEN RAY SOCIETY, Swampscott, Mass., Sept. 3–6, 1924.

pagation of the stimulus along a nerve which is normally without a decrement, in the ameba the stimulus is propagated with a decrement. That is, the intensity of the stimulus falls off with the distance from the point of irritation. This is indicated in the diagram by the varied widths of the concentric lines. It is supposed that the stimulation gradient is the cause of the metabolic gradients referred to above.

The ameba under normal conditions will throw out a pseudopod at the point *a* which will now become the anterior end of the organism. The opposite pole of the ameba is the posterior end. The mass of protoplasm is no longer homogeneous with respect to stimulation or to metabolism. It has acquired a bipolar organization, an anteroposterior differentiation. There is a metabolic gradient sloping downwards from the stimulated to the non-stimulated end.

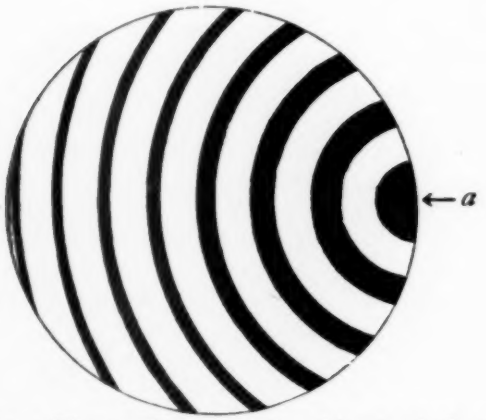


FIG. 1. Diagram illustrating the origin of a single axial gradient in protoplasm: *a*, the point of action of the external factor (*from Child*).

Suppose now that this organized ameba is further irritated at the point *b*, Figure 2. Since the rate of metabolic activity is not so high as at the point *a*, the effectiveness of this stimulus will be less than that of a similar stimulus applied at the point *a*. That is, the point *a*, having already been stimulated and having gained metabolic ascendency, is able to maintain its dominance until either the metabolic activity dies down or until a sufficiently strong stimulus is applied at some other point.

METABOLIC GRADIENTS

I fancy that just what we mean by increased rate of metabolism is not always clear in our minds, but I think that we understand the expression well enough so that I do not need to take time to define it. There are a number of methods which have been used in measuring the metabolic rate. One of these methods is based on the fact that tissues which have a high metabolic rate are more susceptible to poisons.

Child has made use of this fact and has used the degree of susceptibility to poisons as a measure of metabolic rate. In his investigation Child used some fifty odd species of animals, but he did most of his work with planarian worms. The animal is simply immersed in a solution of a poison. Destruction begins in that part of the animal having the highest metabolic rate.

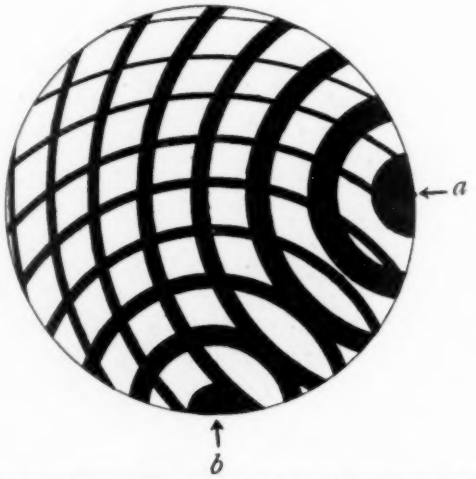


FIG. 2. Diagram illustrating origin of major and minor gradients in a simple case: *a*, apical region of major gradient, *b*, apical region of minor gradient (*from Child*).

Child, in his experiments, using a solution of potassium cyanide of a suitable concentration, found that in the case of the planarian worm, destruction begins at the anterior end. This is one of a number of things that indicate that the metabolic rate is greater at the anterior end of the worm than at the posterior end.

PHYSIOLOGICAL DOMINANCE

In order to illustrate physiological dominance I will again quote from Child's

book on "Individuality in Organisms." The flat worm, *Planaria dorotocephala*, was one of a number of species which Child used in his experiments. This organism is highly differentiated as a bi-symmetrical form with distinct head and brain and two ventral nerve cords with a definite though rather diffuse alimentary and excretory organ. Under certain conditions sexual organs appear in this form but ordinarily reproduction is asexual, the organism undergoing fission, after it has obtained a certain variable size, by dividing into anterior and posterior zooids.

Before fission there is no morphological indication of a second individual or zooid in the posterior region of the body, but one or more such individuals are indicated according to Child's experiments by metabolic gradients of the major axis and by various other physiological differences.

The highest region of this gradient is the head of the animal and from the head the metabolic rate decreases to the level where separation occurs in fission. There is a sudden rise in rate at this point and then again a downward gradient toward the posterior end. The region where the rate rises suddenly represents the anterior end of the second individual and the downward gradient following this is the gradient of the major axis of this second zooid. The zooids form as a result of successive physiological isolations of the basal region as the animal grows in length.

The act of fission in this animal consists of an independent motor reaction of the posterior zooid or group. When the worm is creeping quietly the posterior zooid suddenly attaches itself to the surface on which the animal is creeping, and refuses to follow while the anterior individual endeavors to advance, with the result that the body in front of the attached region becomes greatly stretched and finally ruptures.

The occurrence of fission can often be controlled experimentally by keeping the organism on a layer of vaseline or other substance to which it cannot attach itself. In this case fission is prevented by taking away from the posterior end the possibility of a successful rebellion. On the other hand, if one cuts off the anterior end of a planarian worm which is nearly ready to divide the dominance is, of course, destroyed and the organism divides immediately.

I should like to present one more illustration, also from the experimental investigations of Child. When a bean seed germinates the seed is raised above the surface of the ground, the seed coats fall off and the two fleshy halves of the bean seed become the cotyledons or first leaves of the young seedling. The leafy portion of the bean plant is developed through the unfolding and growth of the terminal bud or plumule which occupied an axial position between the two cotyledons of the bean.

The cotyledons are a storehouse for food which nourishes the plant until it has formed a sufficient number of green leaves to manufacture its food through the process of photosynthesis. Now, in the axils of these cotyledonous leaves there are buds, which normally lie dormant and so do not develop. Thus the young bean seedling has but a single shoot, or stem. Branching, when it does occur, is the result of the growth of the axillary buds of some of the later formed leaves.

Now, it is quite obvious that the buds in the axils of the cotyledons are not prevented from development because of a lack of food supply, for of all of the buds they are the nearest to the food store. By simply cutting off the terminal bud one can demonstrate quite easily that it prevents the development of these axillary buds by its dominance. For when the terminal bud is cut off the buds in the axils of the cotyledons begin to develop at once and the bean plant grows two main stems.

Child has devised another very interesting experiment for demonstrating the dominance of the terminal bud. He coiled a rubber tube about the stem of the bean plant, above the cotyledons, making the coils large enough so that they did not touch the stem, and passed cold water through the tube so as to chill a section of the stem. This chilling shut off the dominance of the terminal bud and the buds in the axils of the cotyledons began to grow at once. This stimulation to growth of the buds in the axils of the cotyledons was not caused by the shutting off of the flow

of food to the upper part of the plant because the terminal bud continued to grow at a normal rate, since its temperature had not been altered. In other words, a bean plant having three main branches was produced.

After the growth had been started in the axillary buds Child permitted the stem to warm up to the temperature of the room. The axillary growths were inhibited at once. Child found by alternately chilling and warming the section of the main stem that he could start and stop growth of these axillary buds at will. The growth of these axillary buds could be controlled by thus limiting the dominance of the terminal buds until these extra branches had attained a considerable size. They had then become independent of the dominance of the terminal bud. After this stage had been reached chilling of the main stem had no further effect upon the growth of the side branches.

Physiological dominance and physiological isolation may be most beautifully illustrated by the growth and development of insect galls. Not only are the phenomena illustrated with many interesting and significant variations but in the case of the insect galls it is possible to trace the evolution of the host, the insect and the gall, and one may note how the insect has gradually learned how to physiologically isolate certain cell masses of the plant and impart to them a dominance which results in the formation of a very complex structure with tissue quite unlike that normally found in the plant, and an organization most marvelously adapted to the needs of the development of young insects. The thought that man may sometime learn to control growth and development as the insect has is a very interesting speculation.

PHYSIOLOGICAL ISOLATION

I think it may be helpful to present the notions of bipolar organization, of stimulation, and of metabolic gradients by pointing out an analogy between the organization of an ameba and of the members of this society gathered in this room. Like the granules of the ameba protoplasm the individuals in this room are of different ages, and they have, after a period of heterogeneous occupations and experiences, found themselves gathered into a distinct body which we will compare with the pseudopod of an ameba.

At the present moment I occupy a position at the anterior end of the pseudopod. My remarks constitute an irritation (using the word in a purely technical sense), and the stimulus is propagated from the anterior toward the posterior end of this pseudopod. Because of the acoustic difficulties and the inability of those at the back of the room to observe my facial expression, and the unavoidable confusion that attends any such gathering, this stimulus is propagated with a decrement.

A stimulation gradient is accompanied by a metabolic gradient. It is easy to observe that those in the front of the room are giving me much more undivided attention than those in the rear. From time to time I observe small groups of individuals near the back of the room who are apparently paying no attention whatever to my remarks. They are neoplasms *psychologically isolated* from the organization, and in some associations when such disturbances become too pronounced a surgical operation is called for by the sergeant-at-arms.

Now, stimulation gradients, metabolic gradients, physiological dominance and physiological isolation are characteristics which may be easily demonstrated in a single celled organism such as *Amoeba proteus*.

If one observes an ameba in the pursuit of its prey it is not difficult to be convinced that the anterior pseudopod controls or dominates the activities of the entire organism.

Figure 3, for example, taken from "The Daily Life of *Amoeba proteus*" by David Gibbs, (*Amer. J. Psychol.*, 1908, xix) shows an ameba in the pursuit of an infusorian. The infusorian has swept past the ameba and in such a manner that the ameba has been stimulated to pursuit. One observes that the stimulated pseudopod advances rapidly along the path of the pursued infusorian and, further, that the formation of other pseudopods is inhibited. Inhibition is illustrated more nearly perfectly in Figure 4 ("Behavior of Lower

Organisms" by H. S. Jennings, Columbia Univ. Press, 1915) in which the ameba has assumed a clavate form and pursues a particle of food, in this case a spore, with what by analogy we might call an undivided purpose. The ameba has become elongated in the direction of its motion. Pursuits of this kind may continue for fifteen to twenty minutes, during which time the ameba has a single axial metabolic gradient, that is to say, the stimulated pseudopod has suppressed all other metabolic gradients.

It is in this sense that the stimulated pseudopod dominates the pseudopod formation of the organism. It will be observed

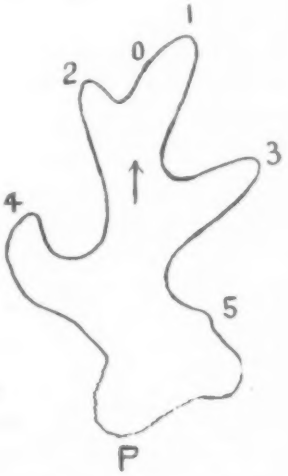


FIG. 3. Diagram showing an ameba in pursuit of an infusorian (*from Gibbs*).

that this dominance is correlated with and is an expression of a localized, heightened metabolic activity.

Figure 5 shows another ameba in the pursuit of a spore. In this case the dominance of the pseudopod *X* is not sufficient to control the activities of the entire organism. The ameba has a divided purpose or what we might by analogy call a "double personality."

Since the stimulus is propagated in an ameba with a decrement, the probability of an ameba having this sort of a divided purpose increases with the size of the ameba. The time comes when a part of the ameba becomes *physiologically isolated* and, like the planarian worm, it divides, and two organisms result.

If we may measure metabolic activity by observing the susceptibility to poisons we would expect, when we subjected an ameba to a poison, such as a solution of potassium cyanide of suitable concentration, that the destruction of the protoplasm would begin at the anterior end of the pseudopod and that the wave of de-

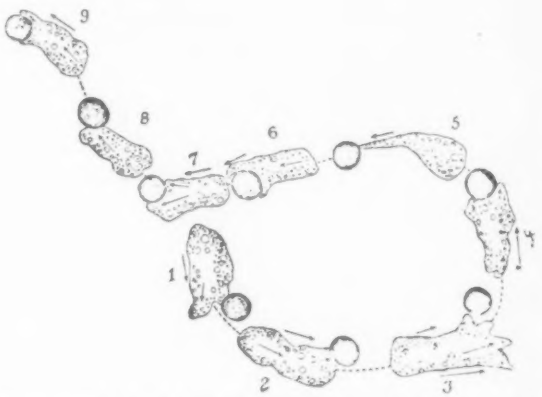


FIG. 4. Diagram showing an ameba following a rolling *Euglena* cyst (*from Jennings*).

struction would be propagated backward toward its base. This is precisely what Miss Hyman set forth in her article "Metabolic Gradients in Amoeba and their Relations to the Mechanism of Amoeboid Movement" (*J. Exper. Zool.*, 1917–18, xiv, 55).

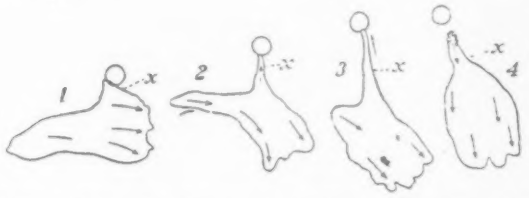


FIG. 5. Diagram showing a single pseudopodium (*x*) reacting positively to a *Euglena* cyst, its protoplasm flowing in the direction of the cyst and pushing it forward, while the remainder of the ameba moves in another direction. 1–4 successive forms taken. At 4 the reacting pseudopodium is pulled away from the cyst, whereupon it contracts (*from Jennings*).

With this introductory discussion I may now describe the experiments that we have conducted in order to demonstrate the relation between physiological dominance and susceptibility to radiation. The experimental procedure is very simple and the implication of the results of the experiments will be readily understood.

A microscope provided with a quartz condenser and a quartz right angled prism for reflecting a beam of ultraviolet light from a monochromatic illuminator was used. The source of light was a spark between specially devised, rotating, self-cooled magnesium terminals. The organisms were mounted on a quartz microscope slide. The wave length of light used was 280 $m\mu$. The intensity of the beam was sufficient to cause cytolysis in about three seconds.

When we thus exposed an ameba to ultraviolet light we found that cytolysis in 77 per cent of the cases began at the tip of the most recent pseudopod. The following table gives the results of a number of experiments.

Cytolysis began	No. of Trials	Percentage of Trials
In last pseudopod	50	77
At base last pseudopod	11	17
More or less central	2	3
Posterior end of ameba	2	3
	65	100

Bearing in mind the difficulty of watching the entire body of the animal at the same time, these results seemed very demonstrative. In only 6 per cent of the exposures did the cytolysis begin at a point far removed. In 17 per cent of the cases the disintegration began near the base of the youngest visible pseudopod, though no actual protrusion was observed in any of these cases. It seems reasonable to suspect that these were regions of incipient pseudopod formation for these were quite surely the regions where such pseudopods would originate. That cytolysis began at the advancing tip of the ameba in 77 per cent of the cases and probably in 94 per cent is interesting. In other words, cytolysis began at the point of highest metabolic activity and in that region of the organism where physiological dominance was highest.

We anticipated that the results of this experiment would be particularly interesting because we had stimulation gradients, metabolic gradients, physiological dominance and susceptibility all within the confines of a single cell. This makes it possible to carry out our analysis of the phenomena a little farther.

When we say a high metabolic activity, if we mean anything, we must mean that chemical changes are occurring more rapidly where metabolism is high than they are in places where metabolism is low.

Ordinarily, we increase the rate of chemical reactions when we raise the temperature. It is a general rule that an increase in the temperature of 10°C. doubles the velocity of a reaction. Now, it was pointed out a long time ago by Arrhenius that this phenomenon cannot be accounted for by supposing that the mechanism connecting the increase in velocity with the increase in temperature is the number of kinetic collisions between the reacting molecules, because the increase in velocity is much too great to be accounted for in this manner. Arrhenius, therefore, proposed the theory that at any one time only a fraction of the atoms or molecules of a reacting mixture are in a proper condition to permit chemical reactions. As he pointed out we have evidence of this in the fact that most chemical reactions do not proceed with an explosive velocity as would be the case if this were so. Arrhenius supposed that the increase in temperature brought more of the atoms or molecules of the reacting mixture into a condition suitable for chemical rearrangement. In other words, any reacting mixture contains two kinds of atoms: Those which are chemically passive and those which are chemically active.

If now we accept what we may call the twentieth century theory of radiation and subatomic structure, those atoms which change from the chemically passive to the chemically active condition do so, through absorbing within themselves a number of quanta of energy. This energy is absorbed from the radiation environment. In the now familiar jargon of the subatomic physicist the

$$\text{quantum} = h\nu$$

in which h is a constant and ν is the vibration frequency, so that the higher the vibration frequency of the radiation environment, or the farther it lies toward the ultraviolet end of the electro-magnetic spectrum, the larger will be the size of the quanta of the energy units absorbed.

Now the exact mechanism by which the radiation is absorbed and the whole series of changes which occur in the atom as the result of the absorption are at present unknown, but it appears that in the end the electron comes to occupy an orbit which is more widely flung from the atomic nucleus.

The absorbed energy becomes potential energy of position of an electron and in the case of the chemically activated atom it appears that this electron is a valency electron.

Now we may state our metabolic gradient in a new language. An increase in the metabolic rate means an increase in the velocity of chemical reactions and an increase in the velocity of chemical reactions means that a larger fraction of the atoms are in a chemically active condition, and this means, in turn, that a larger fraction of the atoms have their valency electrons traveling in far flung orbits. That is to say, they have absorbed energy from the radiation environment and we believe that this energy has been absorbed discontinuously in units of definite size which are called quanta. All these quanta are related to the vibration frequencies of the radiation environment.

Now in a living organism it appears that some other mechanism aside from temperature is involved in determining the fractional part of the atoms or molecules that are in a chemically active condition because chemical reactions proceed much more rapidly in living protoplasm than they do in dead protoplasm at the same temperature.

We have a general name for this fact but no general theory. We say that the velocity of the chemical changes in living protoplasm is increased by the presence of so-called catalyzers, but how the catalyzer or enzyme, as it is usually called, activates the atom is at present unknown.

Now, I believe that one of the fundamental differences between the chemical reactions which occur in test tubes and those which occur in living protoplasm will be found to be correlated with the fact that protoplasm is organized. In the organization of protoplasm it appears that we have a mechanism for maintaining a larger fraction of the atoms in a chemically active condition than we normally find at the same temperature in a homogeneous reacting mixture in the test tube. We must believe that the atoms, and, therefore, the molecules of protoplasm, because of the peculiar organization in which they are found, are maintained in a chemically active condition. In other words, they are alive—alive in the sense that they are continually taking part in physiological changes. This, I take it, is what we mean by living.

I believe that a large part of this enhanced chemical activity which is shown by living protoplasm can be correlated with the fact that protoplasm is a polyphase colloidal system. That is, it is composed of materials that are finely divided and that are immiscible with each other. The result is that protoplasm like colloids in general, has a high specific surface. By the word surface I refer, of course, to the interfaces between the immiscible constituents of the protoplasm. And by specific surface I refer to the amount of interface per unit volume of protoplasm. The expression, "high specific surface," therefore, refers to the fact that with a given volume of protoplasm there is much more surface or interface than there would be in the volume of a standard reference substance, such, for example, as an equal volume of water.

Now many of these immiscible constituents have dimensions below the resolving power of the microscope. Some of the larger granules can, of course, be seen in the living protoplasm of an ameba. The granulation seen in fixed and stained sections of protoplasm may be artefacts. The immiscible granules at the interfaces in living protoplasm may be most readily studied by means of ultraviolet photography of living protoplasm.

Figure 6*a* is an ultraviolet light photograph of a living ameba. The photograph has been made by the same ultraviolet ray which was used in the experiment described above. Figure 6*b* shows the same ameba as shown in the previous slide after fifteen seconds' radiation.

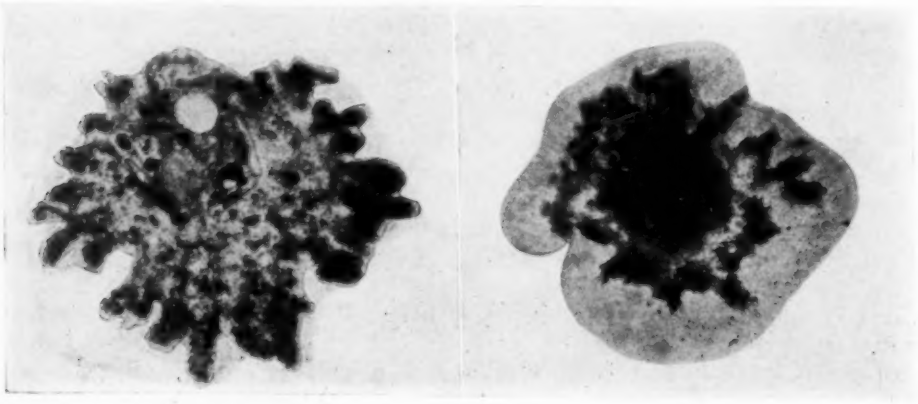
In the light of the previous discussion we may state that the ultraviolet energy

changed to atoms and molecules of the protoplasm into a more chemically active condition, so that chemical reactions occurred at destructive velocities. As you see, the end result has been that the portions of the protoplasm which were immiscible before the exposure to the rays have now become miscible so that they have flowed together and the interfaces have been lost.

That is, the protoplasm has lost this peculiar organization which is characterized by a high specific surface and it is no longer a suitable medium for maintaining the chemical reactions which are characteristic of the living condition.

considered passive and active atoms and I have pointed out that in living protoplasm there appears to be some mechanism other than temperature by which chemical reactions are caused to proceed with a high velocity. All this has led us into a consideration of the nature of the organization of protoplasm and I have just discussed very briefly the nature of photochemical change.

Now I wish to carry the discussion of the organization of protoplasm a little farther and for this purpose I should like to describe some other very interesting experiments which have been performed in our laboratory. The experiments which



a *b*

FIG. 6*a*. Diagram showing an ultraviolet light photograph of a living ameba (original drawing).
FIG. 6*b*. Diagram showing an ultraviolet light photograph of the same ameba after 15 seconds of radiation (original drawing).

This rather roundabout way of saying that the light has caused the ameba protoplasm to cytolize carries a much deeper insight into the nature of the process than the shorter expression "photo-cytolysis."

I think now it would be advisable for us to haul in our log and read off how far we have travelled in our discussion. We have considered the bipolar organizaton of the ameba and we have correlated this organization with stimulation gradients, metabolic gradients and the gradients of physiological dominance; we have discussed the metabolic gradients and correlated them with the velocity of chemical reaction; then we have considered the mechanism by which the velocity of chemical reaction is increased; we have

I am about to describe have been repeated many times.

We mounted under a coverglass, on a microscope slide made of quartz, twenty-five or thirty amebas, and then sealed the coverglass with vaseline in order to prevent evaporation (Fig. 7*b*). The slide was then set away for ten days to two weeks during which time all of the amebas became quieted and they were all in about the same physiological condition. Now we had a device (Fig. 7*a*) which I need not describe, by which we could throw a very fine pencil of ultraviolet light up through the quartz slide and direct it upon a single ameba. An exposure of three or four seconds would cause the ameba to cytolize. A few minutes after cytolysis

was complete other amebas under the coverglass, which had not been exposed to the light at all, gave definite evidence of stimulation and those which were nearest began to move toward the cytolized ameba. As the amebas drew nearer to the cytolized ameba their rate of progress became quickened until as they closely approached it they evidently became much excited and formed food cups, sometimes of relatively enormous size, so that some individuals often had the appearance of a new moon with the concave side directed toward the cytolized ameba, (Fig. 7*c*).

I think you will agree with me that any experiment in which, by the use of ultraviolet light, we can cause an ameba to behave like a phagocyte is extremely interesting, especially to those who have been concerned in the therapy of rickets.

This experiment is also of interest in connection with the problem of the so-called vitamines. As you remember Pasteur observed that yeast cells grew more rapidly when a large loopful of yeast was transferred to a sterile hanging drop of agar, than when only a few yeast cells were transferred. Then Wildiers discovered that the increase in the rate of cell division was to be explained by the fact that when a large loopful of yeast was transferred, dead yeast cells were carried over with the live ones. And further he found that it was possible to obtain an extract from dead yeast cells which would stimulate living yeast cells to grow and divide. He called this stimulating principle *bios*.

As you know this stimulating principle of yeast has now been isolated in a chemically pure condition. The animal physiologists under the leadership of Funk have named the growth stimulating principle a *vitamine*. We might describe these results quite correctly if we stated that after killing an ameba by ultraviolet light the surrounding amebas behaved as if we had released a *bios* or *vitamine* principle which stimulated them to greater activity.

I should like to present for your serious consideration what I think has actually happened in this experiment and for this purpose I must describe in more detail the interfaces in the protoplasm. I must make this description rather brief and give it in a language which may seem dogmatic. In the first place, I believe that the interfaces of protoplasm are molecularly organized. This belief is based on the experimental results of Miss Pockels, of Professors Hardy and Harkins, the extensive experiments of Langmuir and the more recent experiments of Adams, as well as the experiments which I have conducted in my own laboratory. All of these experiments show that the molecules at an interface between non-miscible substances are definitely oriented, especially when those molecules are of the so-called "polar type." That these experimental results may be applied to protoplasm is evidenced

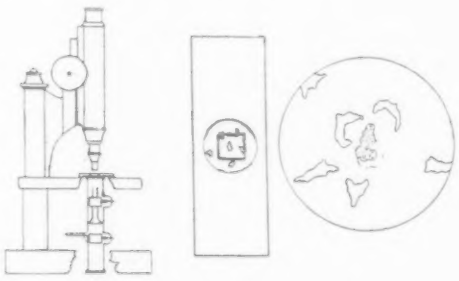


FIG. 7*a*. Illustration showing a device by which a pencil ray of light is directed on a single ameba (original drawing).

FIG. 7*b*. Illustration showing amebas sealed under a cover glass (original drawing).

FIG. 7*c*. Illustration showing amebas drawing near the cytolized ameba (original drawing).

by the fact that protoplasm is composed largely of water, and water molecules of all others, are polar in character. Further, the amino acids which constitute the proteins are characterized by a very high degree of polarity. I shall leave the further discussion of the experimental evidence for this statement, the meaning of the term polarity and precisely what I mean by molecular orientation, to be called for in the discussion of this paper if any of you are interested. Suffice it to say that I believe that the molecules at the interfaces of protoplasm are oriented and that this orientation of molecules is the beginning of a molecular pattern which is specific for each kind of protoplasm; that is to say, that the protoplasm of *Amoeba proteus* has a different interfacial molecular organization

than the protoplasm, for example, of *Amoeba limax* or *Amoeba dubia*.

The different kinds of protoplasm are not to be differentiated so much by their difference in chemical composition as by the difference in their molecular organizations. Each kind of protoplasm has a specific organization which may be compared to the organization of the atoms or molecules in a crystal, excepting that the organization in this case has its origin at the interface and is, as a matter of fact, very much different from the organization that we find in crystals, although specificity of organization is common to both crystals and protoplasm. That such a molecular organization can exist in a fluid substance is shown by liquid crystals. Further evidence of the molecular organization of colloids has been furnished by roentgen-ray studies of soaps and gelatins. I may only take time in passing to state that the molecular orientation at the interfaces is accompanied by an electrical organization and that these electrical organizations form the basis of the phenomena which we study in nerve physiology; that is, the "action currents" of nerves and muscles.

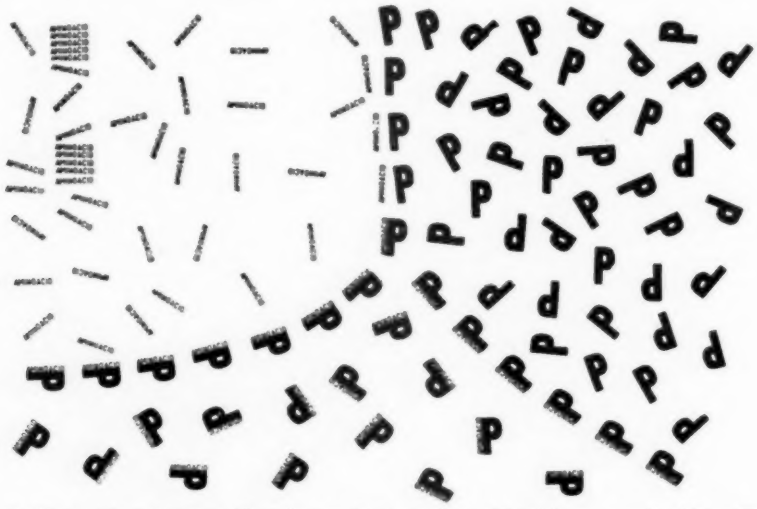


FIG. 8. Illustration showing digestion and absorption of food in an ameba (*from Bovie*).

Suppose that I could magnify the inner wall of one of the food cups in Figure 8, (taken from "The Physiological Effects of Light Rays" by W. T. Bovie, Harvey Lectures, 1924) so that you could really see the oriented molecules at the interface. I have tried to show in Figure 8 what one might observe. The figure is but a diagram and perhaps has one defect in that I have not taken into consideration the very large number of water molecules with which the protoplasm is hydrated. The upper left hand corner of the figure represents a vacuole in which there is a portion of disintegrating food. This food substance is in the process of digestion; it is splitting up into simple amino acids which are polar molecules. The upper right hand portion of the figure represents a small granule of protoplasm, the letters P representing the molecules of the protoplasm, and in order to avoid postulating any specific organization I have represented them as having no organization at all excepting along the interface which separates this granule from the vacuole. Along this interface both the amino acid molecules and the protoplasm molecules are oriented, and as we pass along this interface from the top of the figure downward, the amino acids are shown coming into closer and closer juxtaposition to the protoplasm molecules until finally at the center of the figure an actual chemical union has occurred.

Now every chemical reaction must consist of at least two steps, first, the orientation or rearrangement of the atoms into

the positions which they must occupy in the newly formed molecule, and second, the process of closing up the bonds of chemical valence. In an unorganized chemical reaction such as probably occurs in a beaker in our laboratory this orientation of the atoms into the pattern of the formed molecules is one largely of chance.

The chemical bonding can only occur when the proper orientation has been assumed, but in the protoplasm, you see, because of the orientation of the protoplasm molecules due to their polarity on the one hand, and the orientation of the amino acid molecules due to their polarity on the other hand, the chance factor in the process has been entirely eliminated and the chemical reaction can proceed in an orderly manner and at a speed determined only by the rate at which the substances can diffuse into the interface, and the rate at which chemical bonding can occur. Thus we see at least one way in which the high specific surface of protoplasm is responsible for the enhanced velocity of chemical reaction.

If I had taken the time to discuss the electrical organization at this interface I think I could show you a mechanism by which we might account for the increased chemical activity of the interacting atoms.

This mechanism which I have described to you may, I believe, be the basis of the phenomenon which we know as life.

If now the new compound which has been formed by the union of the amino acid and protoplasm molecules is not miscible with either the vacuolar sap or the surrounding protoplasm these molecules will gather themselves into a new granule which, because of its non-miscibility will now have an interface separating it from the granules shown in the upper right hand corner of the figure, and again along this interface, there will be a molecular orientation with the accompanying electrical organization. It is at these interfaces that the chemical reactions which constitute metabolism occur.

You will observe that I have pictured the mechanism by which the colloidal nature of protoplasm propagates itself, so that we may say that once a colloid, always a colloid, until its organization is destroyed as, for example, by radiation with ultraviolet light as shown in Fig. 6*b*.

I have found it very profitable to devote some time to the study of the nature of organizations in general, and to discover, if possible, fundamental laws which may be applied to all organizations. I have noted a phenomenon which may be raised to the height of a fundamenal law which I have called the "momentum of organization." I may illustrate this in the following manner. Suppose I have a large box filled with objects of a simple geometric form as, for example, a set of cubes, and that along the bottom of the box I fix the cubes in a definite order. Let us say I stand them on one corner and then suppose that the other cubes are piled into the box in a perfectly irregular manner. I shake the box and thus agitate the cubes until they have assumed the most stable position possible. It will be found that the most stable position, that is, the one having the least free energy, will be the one in which all of the cubes are standing on their corners, so that they fit with those which form the bottom layer.

Now the same thing would have happened had I arranged the bottom row of cubes in any other position. The position of least energy would be the one in which all of the cubes had assumed the same orientation as the cubes in the bottom layer. We may, I believe, apply this to the molecules of proteins, hydrocarbons and carbohydrates which form the substance of the protoplasmic mass.

Further, this law of "organization momentum" may be applied to non-material organizations. For example, when the band marches down the street all the boys begin to fall in and mark time; the men and women on the pavement move with a rhythmical tread. Or we may carry the law into the realm of psychology and we will find that the condition of least free energy, that is, the condition when we feel the most comfortable about things, is when the new ideas have been fitted in with the old ones which we call our personality or our way of looking at things. Apparently all that is necessary for the working of this law is to have a definite organization, some material to be organ-

ized and a sufficient amount of available energy to bring about the orientation.

In the case of the feeding ameba this energy is supplied by the chemical attraction between the amino acids and the molecules of protoplasm. That is to say, the protoplasm is hungry for the amino acids and the amino acids in turn, are hungry for the protoplasm.

Let me show you how exposing the organism to radiation enters into the chemical processes which occur at the interface: and in order to do this, I wish to present the process of photosynthesis as I believe it occurs in green plants. I

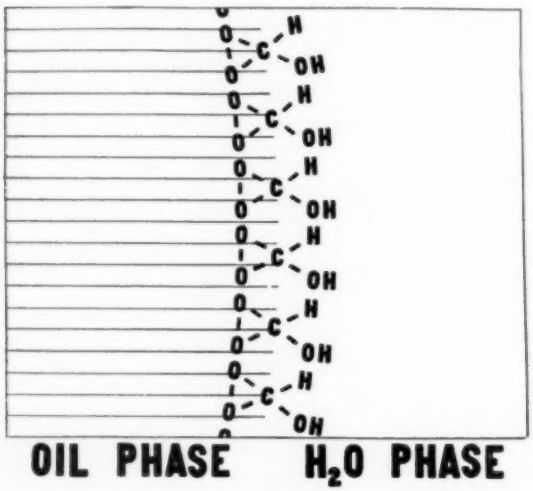


FIG. 9. Diagram showing the possible arrangement at the interface between chloroplast (oil phase) and the surrounding protoplasm (H_2O phase) (*from Borie*).

have taken the process of photosynthesis, first, because as a botanist it is a subject in which I have been interested for a very long time; second, because it is a process which lies at the basis of all living organizations, and third, because it is a process that, notwithstanding its fundamental nature, has not been well understood.

As you know the green plant contains a coloring matter, chlorophyl, which is contained in a small bit of protoplasm known as a plastid. It appears that the chlorophyl is dissolved in an oil. Since the chlorophyl molecules are polar in character we may assume that they are oriented at the interface separating the oil and water phases of the protoplasm. There is at least microscopical evidence that the chlorophyl is concentrated at this interface and the burden of proof lies with those who maintain that the chlorophyl molecules are not oriented.

When carbon dioxide is dissolved in a system composed of oil and water phases, most of the carbon dioxide will be found dissolved in the oil phase, since in general, gases are more soluble in oil than they are in water. And if the molecules of carbon dioxide align themselves at the interface between the oil and the water in such a manner that the transition from the oil to the water phase may be made less abrupt, then it can be shown by an application of the second law of thermodynamics that this arrangement will take place. There is plenty of evidence to support the idea that when carbon dioxide is dissolved in water a certain fraction of all of the molecules will take on the so-called "peroxide arrangement." It seems to me that if these peroxide-arranged molecules of carbon dioxide become oriented in the interface as shown in Figure 9, then the transition between the oil and the water phase will be less abrupt, for these carbon dioxide molecules can now unite with a molecule of water and form monobasic carbonic acid.

This union of the carbon dioxide molecules with the water molecules is a reduction process and is an endothermic chemical reaction. That is, it is a chemical reaction which can only occur when energy is supplied from the surrounding medium, and is a reaction which stores up energy. In this case the energy is supplied by the heat radiation of the environment. It is, therefore, supplied in small quanta, since heat radiation has comparatively low vibration frequencies.

The next step in the process of photosynthesis, the splitting off of the oxygen from the carbon dioxide molecules, is also a reduction process and an endothermic reaction, and it appears that this reaction requires that the atom be very highly activated chemically, and that this activation can only be brought about when the energy is supplied in large quanta, that is, it is a photochemical reaction. We can cause this reaction between carbon dioxide and water to occur if we radiate

the mixture under suitable conditions with ultraviolet light. This is an experiment which I used as a classroom demonstration over ten years ago. In the green plant, however, in the presence of the fluorescent chlorophyl the reaction can be brought about by red-orange light. That is to say, the reaction can be brought about from a radiation environment supplying the energy in smaller quanta. It seems that the chlorophyl is able to store up energy in small quanta and to pass it on to the reacting carbon dioxide molecules in the form of large quanta. This, of course, is an example of the so-called regular "photodynamic reaction" which has already assumed some importance in radiotherapy.

The chlorophyl also serves another function. Chlorophyl exists in two forms, chlorophyl A and chlorophyl B. Chlorophyl A is converted into chlorophyl B by the addition of an atom of oxygen and it is believed that this union of the oxygen to the chlorophyl A to form chlorophyl B takes care of the nascent oxygen so that the chemical reaction does not reverse itself. There is a ferment present which causes the chlorophyl B to be converted back into chlorophyl A, thus liberating molecular oxygen. The atom of the molecular oxygen has lost its chemical activity. It has become a passive atom and will not react. When we have removed the oxygen from the carbon dioxide we have left two valency bonds of each carbon atom freed and if these valency bonds swing around so as to unite six carbon atoms in a row we have practically formed a molecule of sugar.

One other atomic rearrangement is necessary which can easily be accounted for but which I will not describe here.

Suffice it to say that the molecule of sugar is more soluble in the water phase than it is in the oil phase, so that the newly formed molecule of sugar will now diffuse out into the water phase and leave the interface separating the oil from the water free, so that the process can become continuous.

We now see that we have a mechanism which will account for the fact that the plant does not form racemic sugars, that is a mixture of right and left hand sugar molecules.

The sugar molecules have been made on a one-sided machine and they will be either levuloses or dextroses as the case may be. The sugar molecules come out of the interface like chips off a turning lathe.

The process of photosynthesis as I have described it will serve to emphasize the importance of the molecular orientation of protoplasm which has its origin in the interfaces as well as the fact that chemical reactions occur in the interfaces. It thus gives us an idea of how radiation may alter the speed of chemical processes that occur at the interfaces.

So far I have only emphasized the organization of protoplasm in the three dimensions of space, but I should like to call your attention to the fact that in this process of photosynthesis, if chemical reactions are not properly timed the process will be interfered with. Photosynthesis consists of a *series of events* which must occur in a definite order and which must bear a certain time relation to each other.

All of the events of metabolism, that is to say, all of the chemistry of physiological change has this element of time in it. In other words, in order that the physiological processes which occur in protoplasm may continue, the velocities of the various chemical changes must bear certain relations to each other. The process of physiological change consists of a *series of events.*

Events mark off the duration of time. Protoplasm is organized not only in the dimensions of space but the processes of life are organized in the dimension of time. Therefore, I would like to present for your consideration another universal law of biological organization; namely, that living things are organized in four dimensions, having three axes in the dimensions of space and one axis in the dimension of time.

That all living things are organized in the dimension of time is evident when we consider the fact that all organisms have a life history. All of us start as babies and pass along the time axis of our organization to become old men or old women. Indeed, a moment's reflection will con-

vince you that the whole process of evolution is but the organization of living protoplasm along its time axis.

We are now able to state the process of cytolysis by ultraviolet light in a new set of terms. When we expose the organism to light we change some of its atoms into a chemically active condition. Chemical reactions occur at unnatural and uncontrolled velocities. We destroy the organization along the time axis, and the organization along the three axes of space then automatically disappears. The phases of the protoplasm become miscible again and the ameba cytolized (Fig. 6*b*).

We could have produced exactly the same results had we destroyed the organization along one of the axes of space, for then the organization along the other two axes of space would have been destroyed, and concomitantly the organization along the time axis.

HISTOLOGICAL CHANGES IN THE GASTRIC MUCOSA (PAWLOW POUCH) OF THE DOG FOLLOWING IRRADIATION

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THE material which forms the basis of this paper was obtained from Pawlow pouch dogs used by Ivy[5] in the study of the physiological effects produced by exposure to roentgen rays. Early in his experimental work, Ivy noted a decided diminution in the amount of acid in the gastric secretion, and through his kind cooperation the writer was enabled to secure fresh tissue from many of the experimental animals. The histological investigation was begun primarily with a hope that some clue as to the site and manner of the formation of acid might be obtained by studying treated pouches which manifested such striking changes in acid production. Though our results are practically negative from the standpoint of acid formation, still the changes produced in the gastric mucosa by roentgen rays are rather extensive and merit a description.

Very little information can be obtained from the literature on this phase of roentgen-ray injury. Regaud, Nogier and Lacassagne[14] found that the fundic glands had undergone profound changes in a dog which had been exposed to five successive doses during a period of fifteen months. Their illustration showed the chief cells practically obliterated, but the parietal cells were still present. The crypts had disappeared and the free surface of the mucosa was covered with a continuous layer of epithelium. Miescher[12] used Pawlow pouch dogs in experimental studies with roentgen rays. He obtained physiological effects very similar to those described by Ivy.[5] Miescher, however, reported that no histological changes could be observed in the mucosa and decided that the effects were entirely physiological in nature. His experiments are somewhat different from those of Ivy since he failed either to protect or to avoid the small intestine. Case and Warthin[1] in their report on effects of radiation on the liver noted also marked atrophy of the gastric glands with mucoid degeneration and vacuolation. Localized erosions and necroses were also present in the gastric mucosa. In their work it was difficult at times to distinguish between the effects of the irradiation and the possible changes due to the pathology present. Portis and Arens[13] using short rays have confirmed Ivy's physiological results but their report on the pathology present is not yet published.

In this report only brief reference will be made to dosage since that is fully covered by Ivy.[5] The amount of the doses used

will be stated in percentages of a dog erythema dose, which has been found by Ivy, and Martin and Rogers[8] to be from two and one-half to three times that of the human erythema dose. The Pawlow pouches were exposed to either a single large dose or the animals received at intervals of from ten to twenty days, two, three or four successive exposures. The total doses given ranged from 155 per cent to 200 per cent of a dog erythema dose. The physiological effects observed and the histological changes produced by single exposure and by successive exposures seemed to be alike. It appears, therefore, that the effects of small doses distributed over a considerable period are cumulative. Warren and Whipple[15] have found a cumulative effect on the small intestine but their intervals between doses were much shorter than those allowed by Ivy. They, however, were dealing with a tissue which is apparently much more susceptible to injury by roentgen rays than is the gastric mucosa.

MATERIAL AND METHODS

Fresh tissues were obtained from the Pawlow pouches of the dogs on which Ivy had a definite history of both the roenten-ray exposure and of the behavior of gastric secretion before and after treatment. Formal-Zenker was used as a fixing solution and gave uniform and excellent results. Serial sections were prepared and in each series slides were stained with the following dyes: hematoxylin and eosin, iron hematoxylin, neutral gentian, mucihematin and polychrome methylene blue. The different stains employed had the advantage of presenting a complete picture of the changes occurring in the several tissues and types of epithelium found in the gastric mucosa.

FINDINGS—(A) INJURY

The gastric epithelium of the fundus of the dog stomach contains at least four well recognized types of cells: (1) tall columnar mucous cells covering the free surface and lining the crypts; (2) less differentiated, so-called neck-cells in the neck region or junction of the crypt and tubular portion of the gland; (3) chief or peptic cells, and (4) parietal or acid cells. Besides these at least three other kinds have been described; small granular cells of Heidenhain,[3] mucoid cells,[7] and chromaffin (yellow) cells.[2] We have attempted to follow only the changes occurring in the first four types.

No complete destruction of epithelial elements was observed in the mucosa (Fig. 1) showing the least injury, although many cells in the superficial one-fourth showed unmistakable evidences of injury as shown by their structure and staining reactions. The total dosage in this case was 155 per cent of a dog erythema dose. In another pouch exposed to a total dosage of 205 per cent of a dog erythema dose more complete destruction of epithelial cells was noted (Figs. 2 and 3). In this pouch the superficial mucous cells and the cells of the neck have disappeared, and in many cases the injury has extended to the chief and parietal cells in the superficial one-third of the mucosa. The chief cells in this zone usually undergo cytolysis and the pepsin granules are set free in the lumen of the injured glands. The parietal cells, on the other hand, seldom suffered cytolysis but retained their characteristic form and appearance. Their granules also remained distinct.

In one dog, only the lower portion of the pouch was exposed to roentgen rays. The non-irradiated portion continued to produce acid. The irradiated portion ceased to produce acid and pepsin and at the center of the irradiated area ulcers appeared. A section from one of the ulcers is shown in Figure 4. With the exception of the parietal cells, all the epithelial elements of the mucosa have undergone cytolysis. The parietal cells can be seen scattered through the cellular debris.

There also remains the question of the varying degrees of susceptibility of the several types of epithelial cells. Ivy[4] found that large numbers of the mucous cells of of the dog's submaxillary gland were destroyed by a roentgen-ray dose that amounted to two dog erythema doses or five human erythema doses. Martin and Rogers,[9] using a minimum human erythema dose found, in the intestine of the dog, a marked increase in the number

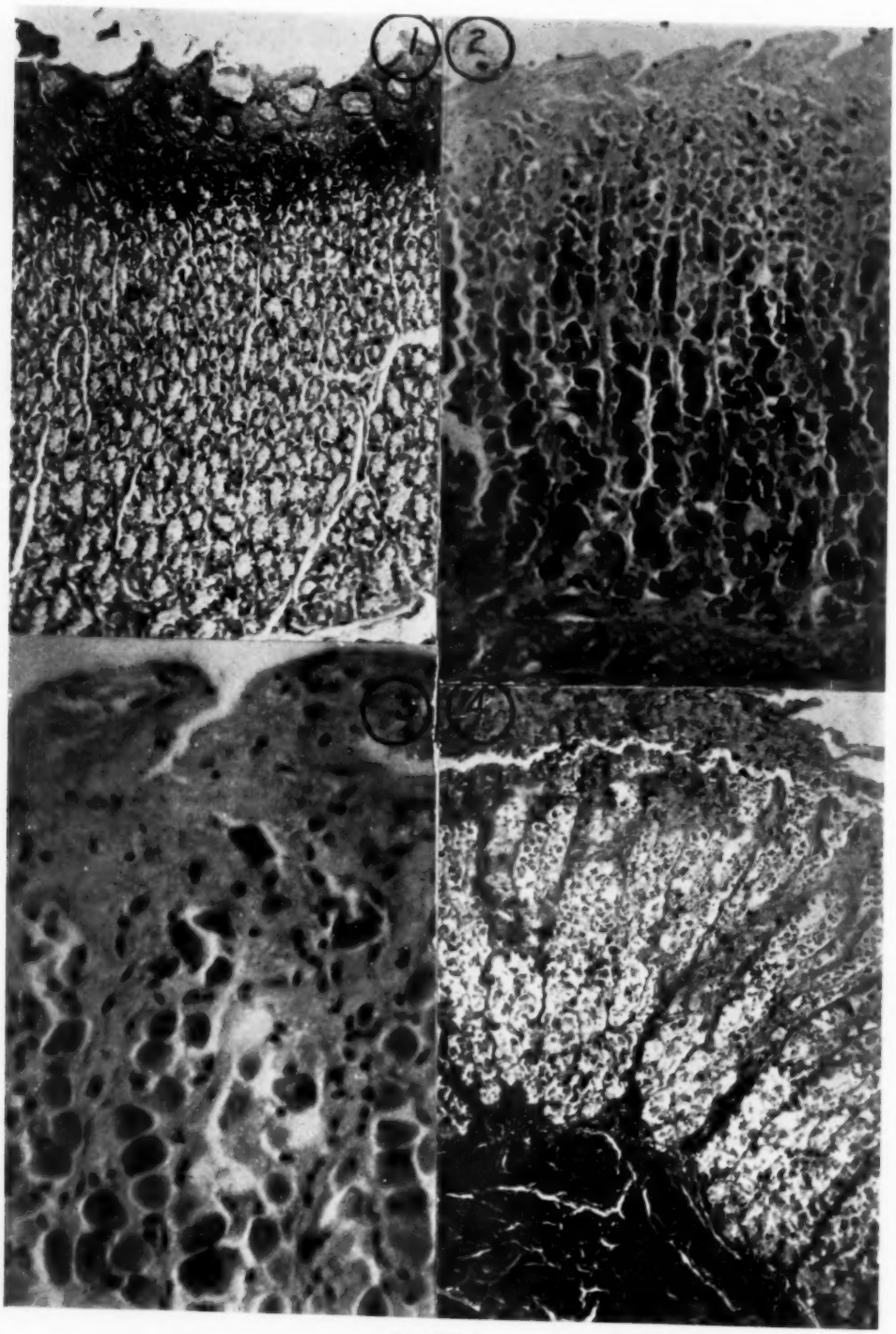

PLATE I.

of goblet cells, almost every cell being deformed by a huge collection of mucus. It appears, therefore, that small doses of roentgen rays may be irritating but not lethal to mucous cells. In some unpublished work on the effect of small doses of roentgen rays and radium on the dog intestine we have also observed a similar response on the part of the mucous cells. It seems possible that the initial reaction of the mucous cells is a hypersecretion, which is followed by exhaustion and dissolution where several successive treatments of a human erythema or more are given.

It is believed that the cells at the neck of the gland are not highly differentiated and that it is in this region that proliferation of epithelial elements by mitosis occurs. The new cells, so produced, move either toward the surface or toward the fundus of the gland, being in the meanwhile differentiated into either mucous, chief or parietal cells. According to this view the neck of the gland is a region of proliferative activity and it is generally conceded that centers of rapid cell proliferation are especially liable to injury by roentgen rays.

It seems quite possible from the physiological results obtained that the parietal cells may fail to produce secretion even when they present no histological evidence of injury. In none of the pouches in which the production of acid was abolished were all the parietal cells destroyed. The main factor involved is probably the blood supply since these cells store no presecretion elements and are apparently dependent on the immediate blood supply for a normal secretory response. The amount of injury done to the chief cells can be judged, I believe, by the amount of cytolysis observed.

The probable order of injury accordingly would be: first, neck cells; second, mucous cells; third, chief cells, and fourth, parietal cells. Though the parietal cells morphologically appear very resistant, physiologically, they appear quite susceptible since chief cells can be found filled with pepsinogen granules while no free acid can be detected in an activated pouch. No multinucleated or giant cells were observed. Binucleated parietal cells were frequently seen but they are often found in a normal mucosa.

So far we have considered only the injuries to the epithelium. Changes could also be noted in the other tissues. In dogs dying within ten to fourteen days following roentgen-ray treatment, petechial and small areas of ecchymotic hemorrhage were found in the mucosa by Ivy, and he preferred to regard the changes in circulation as a passive hyperemia. In more chronic states the mucosa still appeared congested. It is difficult to determine which is injured primarily, the vascular supply or the gastric epithelium; whether the epithelium is injured directly by the rays themselves or indirectly through the effect of the rays on the blood supply, or whether both suffer injury simultaneously and the cytolysis of the epithelial cells is a result of the combined injuries to both. It is, of course, impossible to dissociate injury of blood supply from injury to the epithelium.

No infiltration of white blood cells of any kind was noted in the stomachs examined. This is not surprising since it is well known that doses slightly larger than an erythema

PLATE I

FIG. 1. Low power photograph of gastric mucosa from Pawlow pouch twenty-two days after exposure to 155 per cent of a dog erythema dose of roentgen rays. Note the decided change in staining of the superficial one-fourth of the mucosa. It is in this region that injurious effects are found. Many cells show evidences of degeneration. Roentgen rays administered as a single dose. Stain, iron hematoxylin.

FIG. 2. Photograph (slightly greater magnification than Figure 1) of the mucosa of a pouch twenty-six days after final exposure to roentgen rays. Note the complete disorganization of the superficial one-third of the mucosa. Total roentgen irradiation 205 per cent of a dog erythema dose from successive exposures to roentgen rays during a period of six weeks. Acid completely absent from secretion for five days before tissue was obtained. Stain, hematoxylin and eosin.

FIG. 3. High power photograph of the free surface of the same tissue as shown in Figure 3. Note the absence of all epithelial elements in this superficial zone, except the parietal cells, with practically no infiltration of white blood cells and no proliferation of fibroblasts.

FIG. 4. Photograph (same magnification as Figure 1) showing a roentgen-ray burn or "ulcer" in which the epithelium shows injury as far as the muscularis mucosae. Note the persistence of the parietal cells in the cellular debris. Obtained from an animal twenty-two days after the last exposure to roentgen rays. Total dose 200 per cent of a dog erythema dose, administered in 2 parts of 100 per cent each with a 27-day interval. Acid absent from secretion in the area exposed. Stain, iron hematoxylin.

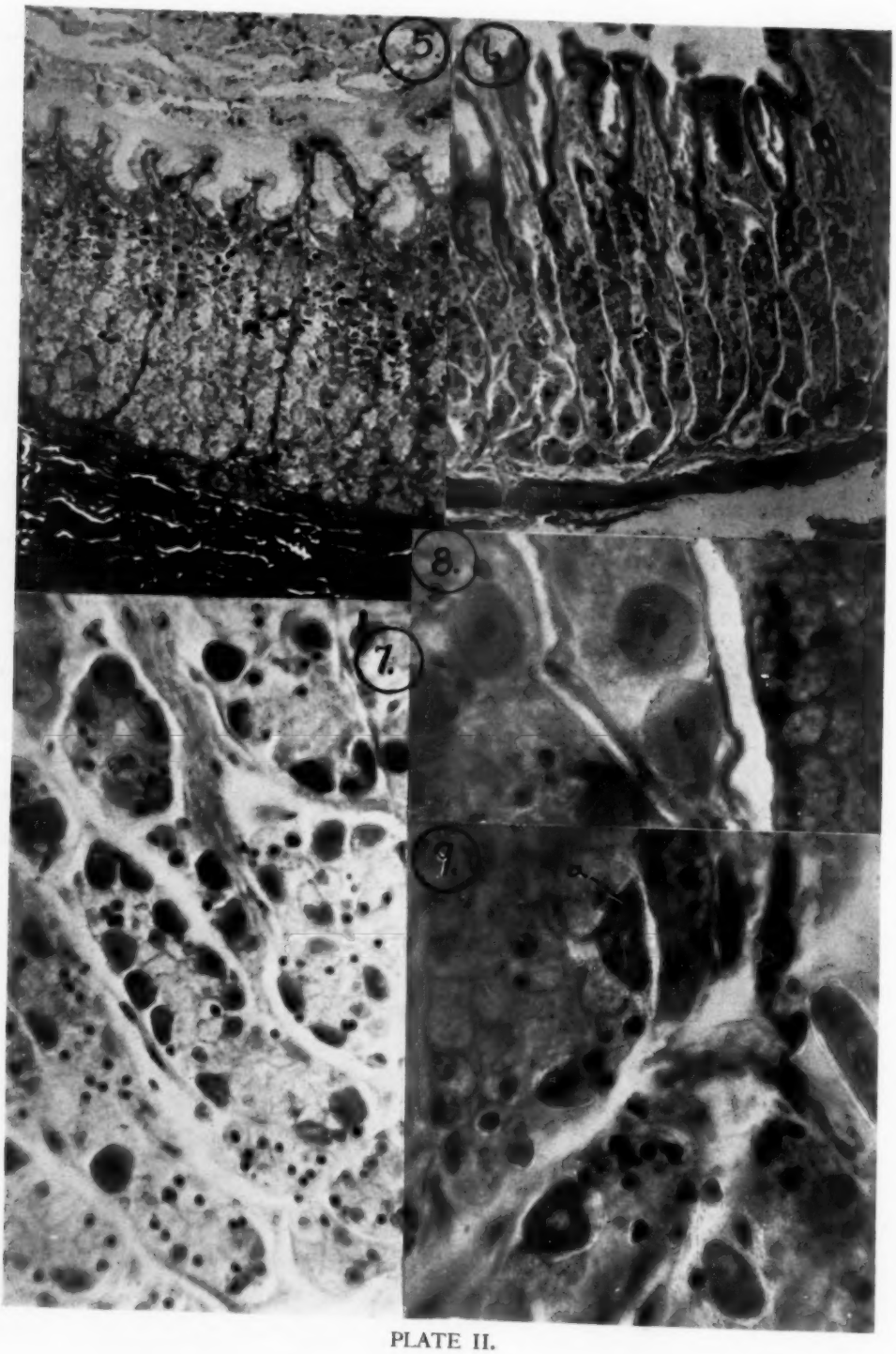

PLATE II.

dose, if repeated several times, will cause an atrophy of lymphoid tissue and the smallest dose delivered in this study was 155 per cent of a dog erythema dose or about four times a human erythema dose.

Another interesting feature of the roentgen-ray injury is the paralysing effect on the fibroblasts. These showed some hypertrophy but practically no proliferation was observed. This delayed response of the fibroblasts has been observed in subcutaneous connective tissue by Maximow[11] and this delayed reaction seems quite important since no epithelial regeneration can be looked for until a healthy connective tissue substratum has been established. The behavior of the fibroblasts in this instance is quite different from that found in the irradiation of such glands as the submaxillary,[4] pancreas,[1, 6] and the suprarenal and kidney.[10] The connective tissue in these glands responds actively, producing a fibrosis followed by more or less atrophy of the glandular tissue.

FINDINGS—(B) REPAIR

Unfortunately a complete series of the intermediate stages of the process of recovery was not obtained for study. All pouches which showed restoration of function were found on examination to be histologically complete. The cellular elements which are usually found invading an injured area, as has been noted previously, were noticeably absent, and were not observed at any stage of the reparative process. Phagocytosis of necrotic tissue was not evident. It appears therefore that the dead tissue was sloughed into the lumen of the pouch and that new connective tissue migrated from below toward the free surface and gradually replaced that which was destroyed by the roentgen rays. In the repaired mucosa little if any fibrosis was present. The regeneration of the epithelium must also have been cared for by a proliferation of the elements found in deeper zones of the fundic portions of the glands. However, a very few mitotic figures were noted in the epithelium of these regions.

The mucosa of pouches showing recovery of function differed from the normal in but two important respects, i.e., thickness and staining reactions of the parietal cells. The mucosa of the regenerated pouch was about one-half the thickness of the normal (Figs. 5 and 6). This is in accord with Ivy's physiological findings. He states that even after the secretion had returned to normal acidity, the amount was reduced by 50 per cent of the normal before exposure.

The second noticeable feature, the staining reactions of the parietal cells, was most apparent when iron hematoxylin was employed, although it can be demonstrated with any technique (Figs. 5, 6, 7, 8 and 9). Many parietal cells hold the iron hematoxylin firmly while others are decolorized much more rapidly. The granules in the densely stained cells accordingly are rendered very conspicuous while those in the palely stained cells, although present and of the same density and size, are not easily distinguished. The nuclei of the densely stained cells also show a well defined chromatic reticulum and distinct nucleolus while the nuclei of the pale cells are small and homogeneous and stain densely (Figs. 7, 8 and 9). The distribution of the two types of cells seems variable. In Figure 5 the majority of densely stained

PLATE II

FIGS. 5 and 6. Photographs of gastric mucosa from two pouches following recovery from roentgen-ray injury. Compare thickness of mucosa with that in Figures 1 and 2. Note also the striking differentiation of parietal cells, some staining densely, others lightly, and the intact superficial epithelium. The pouch, from which the tissue shown in Figure 6 was taken, received 160 per cent of a dog erythema dose. Secretion was affected in ten days and acid was absent for seventeen days. Tissue was obtained three weeks after the reappearance of acid, amount secreted at that time being 50 per cent of normal. Stain, iron hematoxylin.

FIG. 7. High power photograph of tissue shown in Figure 6 illustrating further the two types of parietal cells which are so conspicuous in the regenerated mucosa. In the cells which take the iron hematoxylin heavily the nuclei possess a definite chromatin reticulum, and intracellular canaliculi are evident. In the lightly stained cells the nucleus is dense and homogeneous and the intracellular canaliculi are not evident.

FIG. 8. This shows under oil immersion three cells of the chromophobe type emphasizing the points noted for Figure 7.

FIG. 9. Shows at *a* a typical densely stained parietal cell, nucleus with definite reticulum and chromatic knot. This cell also possesses a ductule and intracellular canaliculi which show faintly in the photograph.

cells can be seen in the superficial portion of the mucosa. In Figure 6 they appear to be more evenly distributed throughout the tissue. Sections of normal mucosa stained with the same technique and at the same time did not show such differences in the affinity of the parietal cells for the hematoxylin. The parietal cells of normal mucosa tended to decolorize uniformly in the alum solution.

It has not been possible to correlate differences in the staining reaction of the parietal cells with differences in secretory activity since there is no good criterion by which parietal cell activity can be estimated. Unlike the chief cells they do not accumulate any demonstrable presecretion elements. One would be inclined, nevertheless, to regard the palely stained cell with the pycnotic nucleus as less active.

SUMMARY

Pawlow pouches exposed to roentgen rays show hypochlorhydria followed by achlorhydria. The dose necessary to produce this effect on the acid secretion is from 155 per cent to 200 per cent of a dog erythema dose. The reduction and eventual disappearance of acid from the gastric secretion is associated with definite injury to the gastric mucosa.

The most striking injury occurs in the superficial portions. Mucous, neck, chief, and parietal cells are damaged. The chief cells undergo cytolysis, while the parietal are not so readily broken down. Persisting parietal cells which show no histological evidence of injury are unable to produce acid.

The mucosa shows passive hyperemia. There is no infiltration of white blood cells. The fibroblasts do not respond rapidly and no fibrosis is found. No phagocytosis was observed and the necrotic tissue is apparently sloughed, regeneration occurring from below.

In regenerated mucosa the thickness is markedly reduced but the structure is histologically normal. The parietal cells show marked variations in staining and in nuclear structure. Some cells are pale with a pycnotic nucleus while others stain densely and their nuclei show a definite reticulum. These differences are not so pronounced in normal mucosa.

The delay in healing in these injuries is probably dependent on the the sluggish reaction of the fibroblasts; since there can be no epithelial repair until a healthy connective tissue substratum is established.

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IS IRRADIATION A SATISFACTORY TREATMENT FOR SUBSTERNAL THYROID?*

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THERE appears to be a more or less common belief, often expressed in surgical literature, that roentgen treatment is of little or no value in substernal or intrathoracic goiter. These two conditions are considered in this article as being the same and the terms are used interchangeably, although the writer is aware of the distinction made between the two by various authors. Lahey[1] says, "It is assumed that surgery is accepted as the only curative procedure available in this condition;" and Terry,[2] "Treatment by *X*-ray should not be tried because by far the great majority are adenomas which are not favorably influenced by radiation, and there is danger of producing hypothyroidism by the effect on the normal thyroid tissue."

My own feelings in this matter have always been neutral. That is to say, I have never attempted to exert any influence favorable to irradiation, but have treated only patients in whom operation had been considered and rejected for some reason. However, after a careful analysis of the cases I have treated, I am not ready to accept the opinions quoted above.

A majority of intrathoracic goiters are undoubtedly adenomatous, a few are cystic, a few are colloid, and a few are of the exophthalmic type. The first and last are usually quite amenable to irradiation and when these types of goiter are seen in the neck, it is the common experience of radiologists to expect not only amelioration of symptoms, but also reduction in the size of the enlargement. The chief difference between intrathoracic and cervical goiter is that the size of the tumor is of vital importance in the former. While the size of the neck produced by ordinary goiter may be very distasteful to the patient it is seldom of pathological significance. When the tumor is in the chest, however, the actual size of the mass is often responsible for much of the patient's disability. The displacement of and pressure against the trachea causes dyspnea and attacks of suffocation; the pressure against the great vessels causes congestion of the veins of the head and neck with resulting headache, vertigo and noises in the ears; the pressure against the base of the heart and the sympathetic and vagus nerves causes palpitation and the other distressing manifestations of goiter heart. In addition to these symptoms, the patient often suffers from the usual effects of hyperthyroidism. Any treatment to be successful not only must relieve the hyperthyroidism, but also must reduce the size of the mass so as to relieve the pressure symptoms above enumerated. May we reasonably expect such results from irradiation treatment? The answer depends upon the type of goiter with which we are dealing. Colloid and cystic tumors are entirely unaffected by such treatment. The acute exophthalmic type shows the greatest reduction in size of all goiters. Adenomata are sometimes markedly reduced in size and other cases are apparently uninfluenced in this respect. It is therefore important to differentiate between these types before advising roentgenotherapy. Exophthalmic goiters should be easily recognized and I may say in passing that all goiter cases should have a roentgen examination of the chest before treatment as many cases will show a substernal extension that was previously unsuspected. Colloid and cystic goiters will, of course, show no evidences of hyperthyroidism, but the majority of adenomata will do so. If, therefore, one makes a rule to treat no substernal goiters unless they show symptoms of hyperthyroidism, he will rule out colloid and cystic goiter and the non-toxic adenomata, in all of which no favorable result could be reasonably hoped for. When the hyperthyroid symptoms are masked by the pressure symptoms, the basal metabolism test is of especial value. It is best to treat no case of substernal thyroid unless there is an increase in the metabolic rate.

* Read at the Sixth Annual Meeting, Eastern Section, AMERICAN ROENTGEN RAY SOCIETY, Atlantic City, N. J., Jan. 22–24, 1925.

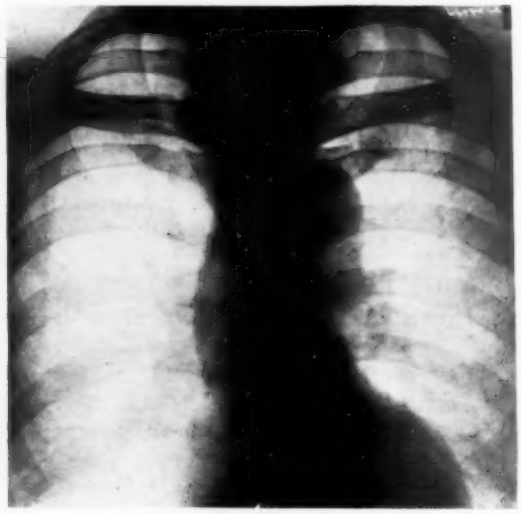
Under such circumstances, one can expect at least a reduction of the hyperthyroidism and also be sure he is not going to do harm by producing a hypothyroidism in a case previously normal in this respect. In regard to the reduction in the size of the mass, these cases appear to resemble thymus cases in that the amelioration of symptoms is out of proportion to the decrease in the size of the tumor. Cases showing a marked relief from their pressure symptoms will present no recognizable decrease in the size of the tumor as demonstrated on roentgen plates made before and after treatment. It may be that the actual shrinkage of the entire mass is greater than can be inferred from the image on a roentgen plate. It is also possible that slight changes in the size of the mass make marked differences in the pressure symptoms. Whatever the explanation, there is no doubt patients show marked relief from their symptoms with little apparent change in the size of the mass. It may be argued that this relief is due only to a lessening of the hyperthyroidism; and that with the mass still in the chest and unaffected by treatment, the seriousness of the patient's condition is unaltered. This point can only be settled by the collection of statistics from a large number of cases followed over a long period of time. My own cases are too few in number to form a basis for any such conclusions.

RESULTS OF ROENTGEN TREATMENT OF SUBSTERNAL THYROID

Free from Symptoms	Improved	Unimproved. Only 1 or 2 Treatments	Moved Out of Town. Treatment Continued Elsewhere	Unimproved
13 cases	4 cases	3 cases	2 cases	2 cases

It will be noted that 8 of the 13 cases free from symptoms have been well longer than three years. It would seem that these results might reasonably be expected to be permanent.

Before.



After.

PERIOD OF FREEDOM FROM SYMPTOMS

10 yrs.	9 yrs.	8 yrs.	3 yrs.	2 yrs.	1–1½ yrs.
1 case	1 case	4 cases	2 cases	1 case	4 cases

Of the 24 cases which I have treated only 3 have received the new deep therapy technique. The results in these 3 cases were so much better and the response so much quicker than anything obtained before that I am certain our statistics will show a marked improvement in the future. I treated my first case in this manner with some trepidation as I was fearful of a possible swelling of the tumor in reaction to the treatment, and a sudden swelling of a substernal mass might be a serious matter. However, there were no untoward symptoms except the usual nausea, and in a short time the patient was remarkably better. A second series of two treatments (one anterior and one posterior) was given

six weeks later and since that time the patient has been entirely free from symptoms for a period of one and a half years. The other two patients treated with deep therapy had already been under treatment for several months with the ordinary roentgen-ray technique and had shown very little improvement. One of these patients received one treatment anteriorly, and the other patient one treatment anteriorly and one posteriorly. Both have been symptom-free now for over a year.

The deep therapy technique which I have employed consists of 80 per cent of an erythema dose applied over each of two areas, one anteriorly and one posteriorly over the mass. These areas are not treated on the same day, but a day or two is allowed to elapse between treatments. The factors used are 200 kv., 4½ ma., 20-in. distance, filters, 0.75 mm. Cu and 1 mm. Al, time 90 min. On my installation this is 80 per cent of a skin erythema dose when given over one area 10 cm. square. The depth dose is about 75 per cent in the average case when two areas are treated, one anterior and one posterior.

A tabulation of the cases we have treated shows favorable results in a little more than half the cases. Nearly all the cases were treated before the development of deep therapy apparatus. I am sure some of our unsuccessful cases would have been benefited by this new technique. This would be particularly true of those cases which soon became discouraged and stopped before sufficient treatment was given. From my experience with the deep therapy technique, one or two treatments are sufficient to give marked relief. Twenty per cent of our cases stopped after one or two treatments, and if these had been deep therapy treatments instead of the ordinary technique, the results would probably have been much better. There should be no danger of producing hypothyroidism by this treatment. Whether the case be of the type where there is a growth downward from the cervical thyroid, or if it develops from an aberrant thyroid primarily intrathoracic, there is still essentially the normal amount of thyroid tissue in the neck. As there is no advantage in treating the neck, the treatment should be confined to the mediastinum. The function of the cervical thyroid then will not be interfered with as there will be plenty of unradiated gland tissue left. The question as to whether the case shall be treated by operation or by irradiation should be given very careful consideration. It has been stated by prominent surgeons that irradiation produces a fibrosis of the gland with adhesions to the capsule and that subsequent operation is made more difficult as a result. If this is true, preoperative treatment in substernal thyroid would be unwise as adhesions between the gland and the capsule might compel the surgeon to remove the mass piece-meal instead of shelling it out intact. The danger of hemorrhage would, of course, be considerably increased by this procedure. However, in contradiction to this, some surgeons state that they experience no increased difficulty in operating on thyroid cases which have previously been irradiated and that the fibrosis and adhesions mentioned above are often found in old goiter cases which have had no roentgen treatment. Until we have positive information on this point I believe it is best to decide beforehand whether we shall use irradiation or operation, and not adopt a policy of treating all cases by irradiation to see what will happen and if the patient does not improve, resort to surgery. It may not always be practical to carry out this plan to the letter. For instance, an inoperable case may be improved but not entirely relieved by irradiation and in the meantime the causes which prevented operation may have disappeared. Subsequent operation on this case may be more difficult than if performed primarily, but probably not impossible. The question as to which treatment is preferable should be decided by a conference between internist, surgeon and radiologist. The operation, of course, is a difficult one and the danger to the patient is not over with its successful completion, as postoperative collapse of the trachea is an ocasional complication. This happens as a result of the atrophy of the cartilaginous rings of the trachea from the long-continued pressure by the tumor mass.

As long as the mass is present it acts as a rigid splint around the trachea, but with its removal the suction which occurs with inspiration causes the weakened walls to collapse and unless this complication has been foreseen and provided for, the patient may smother before anything can be done. The usual dangers of thyroid operations are, of course, also present, with an added danger of a greater probability of serious hemorrhage. However, the high percentage of recoveries from operation reported in the literature is a high compliment to the skill of modern surgeons.

While irradiation offers no particular danger in the application of the treatment, the chances for complete and permanent recovery are obviously not so good as where the mass can be removed. The real problem then is whether operation can be successfully performed without risk to the patient. If after careful examination of the patient and a study of the location and extent of the tumor, the internist and surgeon decide this question in the affirmative, I believe surgery is the treatment of choice. If not, irradiation offers a probability of relief from symptoms in a majority of cases. I believe with the more common use of deep therapy technique in these cases, the results will be much better than in the past.

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COMPARISON OF DIFFERENT METALLIC FILTERS USED IN RADIUM THERAPY

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IN radium therapy at the present time many different substances are used as filters. The primary filter for deep therapy is always a metal, but it may be lead, gold, platinum, silver, brass, or any other of fairly high density (or atomic weight). Each institution has developed its own technique, taking into consideration its own special problems and the results of research by members of its staff. It is evidently very desirable to compare the quantity and quality of radiation being used in these various applications, but so far no basis has been developed for the comparison of radiation transmitted by different filters. When two physicians treat similar lesions with applicators of different materials, it is extremely difficult to compare doses, since there has been no biological criterion of the difference in quality and quantity of the radiation used. The object of the present paper is to set forth a number of relationships that have been found between certain physical and biological measurements and to supply data for the comparison of a few of the most used metallic filters.

Previous work[1] has shown that if two pieces of different metals transmit radiation which produces the same ionization, these filters cannot be called equivalent. If this apparently equal radiation be absorbed in the same substance, that from different filters will not be absorbed in the same manner. This is due to a difference in the quality of the filtered radiation, the amounts of beta, soft gamma, and hard gamma rays varying from one filter to another. Both ionization and biological effects are dependent on the quality and quantity of the radiation absorbed, and the absorption is not at all the same in the air of the ionization chamber and the irradiated tissues, nor, in general, is there a direct proportionality between the two when the quality varies.

In the absence of a definite biological standard of radiation, the skin erythema is generally used as the unit in therapy. Ideas of what constitutes an erythema differ widely from a very slight flush to a strong reddening, which may be followed by blistering. Each therapist establishes his own unit, in terms of which he may adjust his treatments. But in order to make his information available for general use, he must define his erythema objectively, that is, in terms of the quantity of radium used, distance, filter, time, etc., so that others can reproduce it. Thus we have defined our skin erythema as the effect produced on the skin of the forearm of the average adult by exposure to 830 millicurie-hours of radiation from the ordinary glass tube of radium emanation 14 mm. long, with a filter of 2 mm. of brass and 2.4 mm. of rubber, at a distance of 2 cm. from the skin.

As stated above, the two main factors determining the effect of radiation on the skin are the quality and quantity of that which is absorbed in the skin and underlying tissues. In the case of radium the quality is especially important because the radiation used consists of two distinct types, beta and gamma. Neither of these is homogeneous, but consists of a group of so-called "rays" of different penetrating power. It is therefore important to know in any given biological case the type of the radiation and how this is absorbed in tissue, in order to work out a basis or comparison. Having obtained these data, the radium therapist will be better able to compare his treatments with those of others, and to plan improvements in his own methods.

In our investigation of this problem we have used a set of brass filters as a standard. These were chosen because they were the ones with which previous work[2, 3] on skin erythemas had been done and we wished to correlate the results then obtained with those of the present experiments. Biological experiments have determined the skin dose for each of these filters, and physical measurements the quantity and quality of the radiation. Comparisons have been made of the absorption of radiation transmitted by various filters with that transmitted by brass. The absorption may be measured in any organic substance of about the same density as tissue, the important thing is that the measurements with brass and with the filters to be tested must be made under identical conditions.*

Since the beta and gamma rays of radium are physically very different, it is logical to examine them separately, in so far as this is practical. If the rays from a tube of radium or emanation, after passing through any filter, traverse a magnetic field, the gamma rays will not be affected. The beta rays, however, will be deflected from their courses, and if the field is strong enough, they will follow circular paths of small diameter. This is a convenient method of separating the two types of rays.

The apparatus used in the present investigation is shown in Figure 1. MM represent the coils of a powerful electromagnet with pole pieces, PP, 6 cm. square and 5 cm. apart. The current could be turned on or off, or modified at will by switches and a potentiometer, not shown in the diagram. The source of radiation was always a capillary glass tube containing radium emanation, held in a groove at the top of the wooden support T, parallel to the magnetic lines of force, that is, with its ends toward the pole pieces. The rays coming from the tube passed through a slit 3×16 mm. in size, in a piece of brass S, 1 cm. thick. The filter and tissue, or tissue substitute (rubber) were supported on top of the slit. The radiation to be measured entered the ionization chamber, I, through a very thin mica window, and discharged a gold leaf electroscope E. The ionization chamber was of lead several millimeters thick, with a lining of cardboard about half a centimeter in thickness. The lead prevented stray soft radiation from entering the ionization chamber, and the lining was used to minimize the effects of secondary

* Previous experiments in this laboratory (The Absorption of Radium Radiations by Tissues, by G. Failla, Am. J. Roentgenol., 1921, viii, 215) have shown that absorption in rubber is approximately the same as in muscle tissue. Some of these were repeated with the present apparatus. Fresh beef muscle was used as the absorber, frozen and cut in very thin slabs. Different thicknesses of brass were the filters in this case, and the method was the same as with the rubber. The previous results were verified.

radiation given off by the lead. The electroscope walls were also of lead one centimeter thick, with two small windows, shielded from extraneous radiation.

It was necessary to make several preliminary investigations on the apparatus. The ionization chamber and electroscope

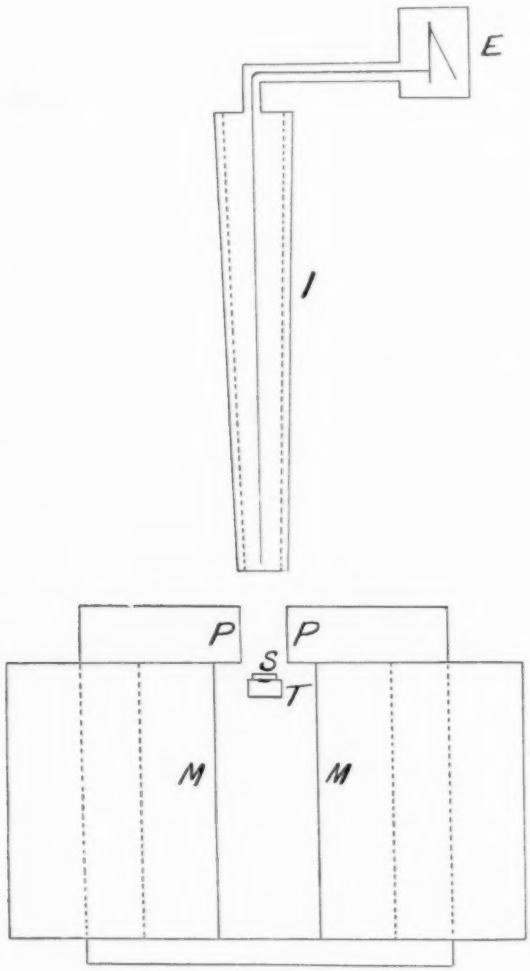

FIG. 1.

were tested for saturation and found satisfactory within a range much greater than that of the experiment. The strength of the magnetic field necessary to remove all the beta radiation was determined, and during the experiments a field much stronger than this was always used.

The metal filters were all 12 × 26 mm. and of varying thicknesses. This small size was used for the sake of economy, since platinum, gold, and silver filters were included in those tested. However, comparative tests were made with brass filters of this size and 40 × 40 mm. and showed very close agreement, so that it was permissible to use the small filters. Since they were placed directly on the slit, no part of the beam of radiation could reach the ionization chamber without passing through the filter.

Since it was impossible to make a slit with sides thick enough to remove all the gamma rays, a conical ionization chamber was used. The apex of the cone was below the tube holder, and the angle of the cone was such that the beam of rays just filled the chamber. In addition, a brass slit one centimeter thick was used. Preliminary experiments showed that brass and lead were equally effective as materials for the slit.

The change in the amount of scattered radiation entering the ionization chamber as the top of the pile of filters approached it was shown to be negligible. The radiation scattered from the pole pieces is, however, an appreciable factor. Since it appears to be always a constant percentage of the gamma radiation present, it may be corrected for, when desired.

With the apparatus adjusted properly, results could be duplicated from day to day with the desired precision.

The metals studied were platinum, gold, silver, lead, brass, and copper. The method of procedure was as follows: For each metal, absorption curves were first obtained. A thin strip of it, of known thickness, was put over the slit and the time of discharge of the electroscope noted, giving a measure of the ionization produced in the chamber by the beta and gamma radiation together. The magnet was then turned on and the tiem taken, giving the ionization due to the gamma radiation alone. Another piece of the metal was added and the procedure repeated until about 2 cm. of filter had been used. These readings gave curves for the absorption in the metal of the total radiation from the emanation tube and from the gamma radiation alone.

To investigate the absorption in tissue substitute (rubber) of the radiation trans-

mitted by any filter a similar method was followed. For each thickness of filter readings were taken with and without the magnetic field. Then a thickness of rubber was added and similar readings taken. The procedure was repeated until a sufficient number of points had been obtained to give a good absorption curve. The total thickness of rubber was about 3 cm. When several thicknesses of the same metal were being investigated the apparatus was so arranged that the metal filters could be interchanged without disturbing the rubber.

In order to have a basis for comparison of the work done at different times an absorption curve for radiation filtered through 2 mm. of copper was obtained at the same time that data for each set of curves were being determined.

Since we wished to use data from previous papers,[2,4] we used the same thicknesses of brass filter as in the experiments there described, namely 0.16, 0.32, 0.50, 0.75, 1.0, and 2.0 mm. For the other metals the thicknesses used were determined as follows: In each case the smallest available was tested, the one necessary and sufficient to give radiation which was exponentially absorbed, and one intermediate one. In the cases of lead and platinum some larger ones were also studied, since they are so often used in therapy. The thickness of filter necessary to give exponential absorption was determined by a process of trial. A filter which was thought to be about right was used and an absorption curve obtained with rubber. If this, plotted to a semi-logarithmic scale, was a straight line, the desired condition was fulfilled. However it was possible that the filter was thicker than necessary, so slightly thinner ones were used until one gave a curve which was concave at the beginning. This was too thin, and the last one giving a straight line was the desired one. If the first one gave a concave curve, slightly thicker ones were tested until one gave a straight line. Table 1 shows the thicknesses actually used.

The absorption curves for the metals are shown in Figure 2. It will be seen that those for gold and platinum coincide, and so do those for brass and copper.

TABLE 1
THICKNESSES OF METAL FILTERS USED IN THE EXPERIMENT

Brass, Mm.	Copper, Mm.	Silver, Mm.	Lead, Mm.	Gold, Mm.	Platinum, Mm.
0.16	0.16	0.10	0.06	0.05	0.05
0.32					
0.50	0.50	0.50	0.20	0.20	0.20
0.75					
1.0					
2.0	2.0	1.1	0.90	0.50	0.50
			2.0		1.0
					1.5

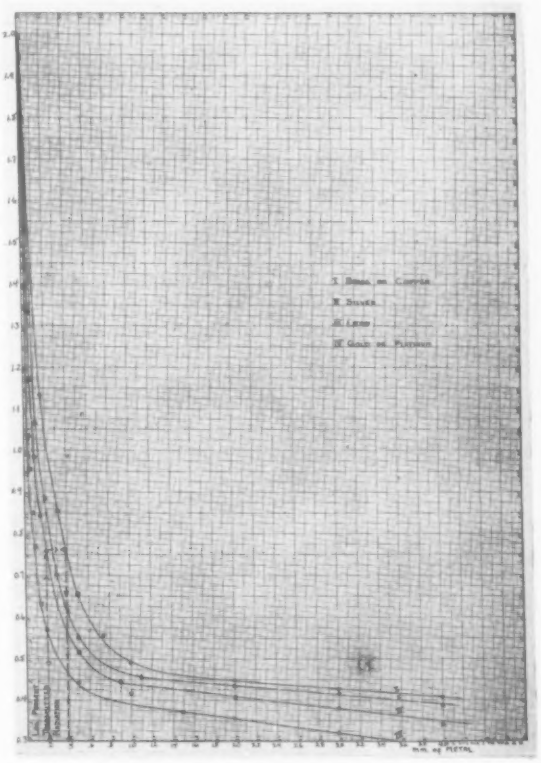

FIG. 2. Absorption by metals of radium radiations. Corrected for scattered radiation.

The curves for absorption in rubber of the total and of the gamma radiation transmitted by various thicknesses of each metal were plotted to a semi-logarithmic scale, and curves for intermediate filters interpolated. A typical set (for brass filters) is shown in Figure 3, the solid lines representing experimental curves, the dotted ones interpolated.

Set 1 of the curves of Figure 3 represent the absorption of the total radiation, Set

11 of the gamma radiation. The curves in the upper right part of the figure are continuations of the main ones, drawn to a smaller scale for thickness of filter and a larger one for percentage, to show what absorption takes place in larger thicknesses of the absorber.*

Curves for the beta radiation may be obtained from those for total and gamma radiations in the following manner: Curve A of Figure 3 is for the total radiation

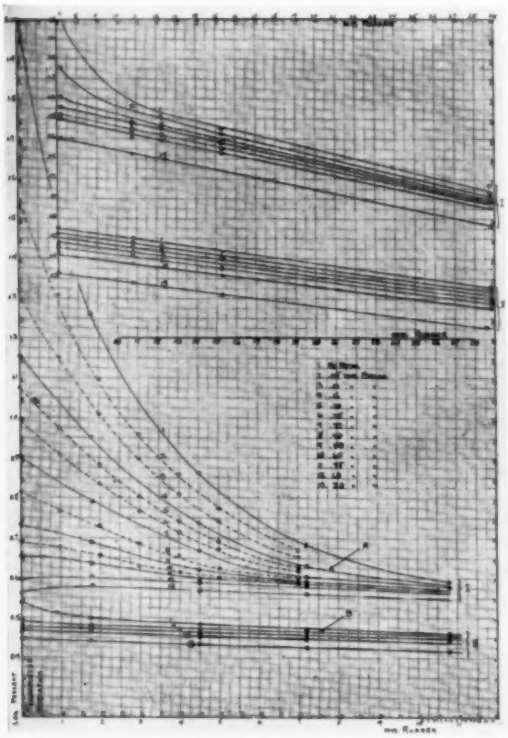

FIG. 3. Absorption in rubber of radiation transmitted by different thicknesses of brass. Not corrected for scattered radiation.

transmitted by 0.16 mm. of brass, and Curve B is the gamma radiation for the same filter. By subtracting the values (percentages) of points for definite thicknesses of rubber on Curve B from the values for the correspondng points on Curve A, a new curve is obtained which gives the absorption of the beta radiation transmitted by that filter. Similarly beta

* The initial increase in the curves for total radiation from thick filters is probably due to secondary radiation from the rubber. This, being very soft, is readily absorbed in the air of the ionization chamber, more than counterbalancing the cutting off of a small amount of the (much more penetrating) transmitted radiation.

ray curves are obtained for every primary filter.

In the first paper referred to above we published data showing that 2 mm. of brass is a sufficient filter for gamma ray therapy, the criterion in this case being the exponential absorption of the radiation in tissue substitute. Figure 3 might seem to indicate that this thickness of brass is not sufficient to remove all the beta radiation, since the gamma ray curves fall

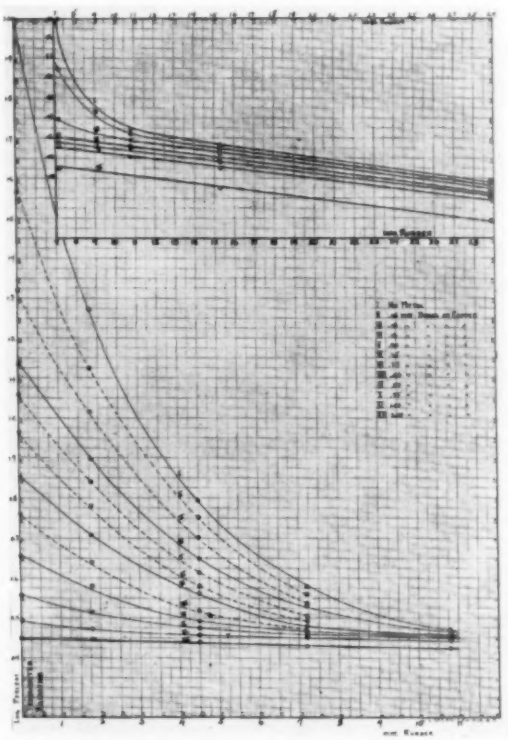

FIG. 4 Absorption in rubber of total radiation transmitted by different thicknesses of brass or copper. Corrected for scattered radiation.

below the curve for total radiation transmitted by 2 mm. of brass. However even with filters as thick as one centimeter of copper such a discrepancy exists. Therefore it is evident that this difference is not due to primary beta rays which go through the filter and are deflected by the magnetic field. It must be attributed to secondary beta radiation set up in the filter, the pole pieces, and possibly other parts of the apparatus.

This secondary radiation appears to be proportional to the amount of gamma

radiation present, and therefore a correction can be applied on this basis. Having done this, we obtain curves for the beta radiation alone and for the total radiation, corrected for scattering. Curves for the total radiation for brass filters are shown in Figure 4. Similar ones were obtained for the other metals. Curves for the beta and gamma radiations are shown separately in Figures 5, 6, 7 and 8.*

We now wish to make practical application of the information contained in these

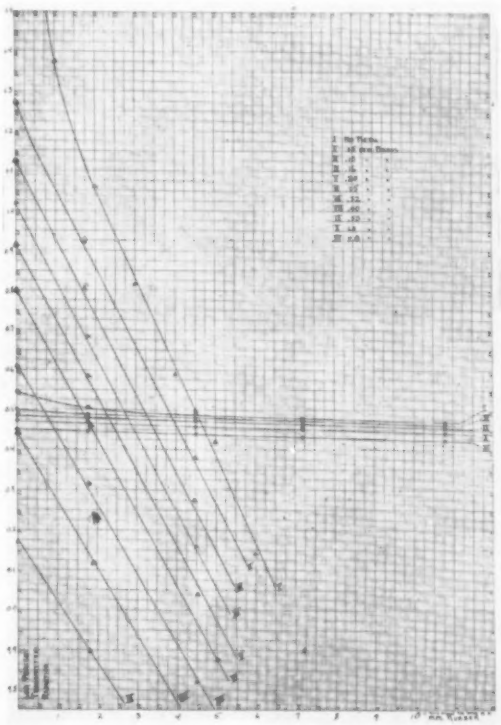

FIG. 5. Absorption in rubber of β and γ radiation transmitted by different thicknesses of brass. Corrected for scattered radiation.

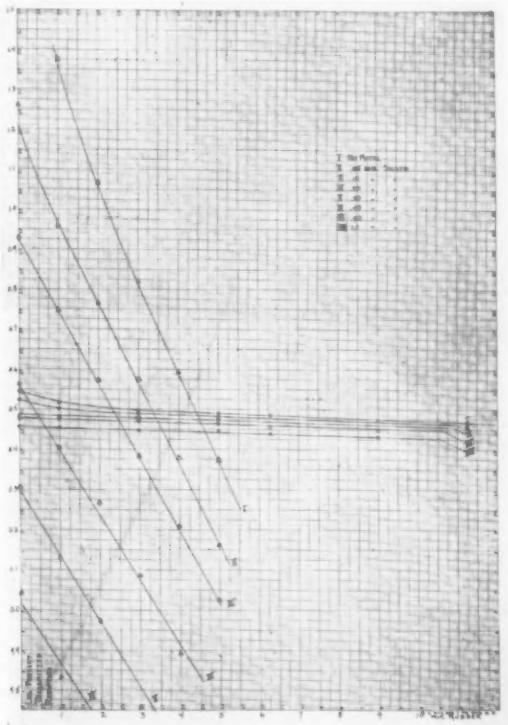

FIG. 6. Absorption in rubber of β and γ radiation transmitted by different thicknesses of silver. Corrected for scattered radiation.

curves. We have measured electroscopically the beta, gamma, and total radiation emerging from a large assortment of filters, and found how this radiation is absorbed in rubber. We can say that *as indicated by our instrument* certain amounts of various qualities of radiation pass through definite thicknesses of tissue substitute. But the usual basis for dosage is the skin erythema, wherefore it is necessary to determine some sort of relation between the laboratory data and the biological information already acquired regarding skin doses.

Comparison of the percentage of transmitted total radiation given by the absorption curve for brass and the biological curve already published[2] gives Table II. Evidently the observed percentage of transmitted radiation depends to a large extent on the effect used to measure it. The two effects here noted, air ionization in the particular chamber used, and skin erythema, seem to have no simple relation, yet we wish to use the first as a basis for determining the second. Therefore it will be necessary to establish an empirical relation between them.

The formation of a skin erythema must be related to the energy of the radiation absorbed. This will depend upon the quality as well as the quantity of the radiation falling on the skin. The beta

* It should be noted that in all these curves the logarithms of the percentages are given, not the actual percentages. Much more accurate data can be obtained from the curves in this way. It is a simple matter to determine the values of the percentages with a four-place logarithm table (see examples given later).

TABLE II

RELATION BETWEEN IONIZATION AND BIOLOGICAL MEASUREMENTS

Filter Mm. Brass Plus Mm. Rubber	Percentage Radiation Transmitted		Ratio $E_{\beta\gamma}/I_{\beta\gamma}$
	Ionization $I_{\beta\gamma}$	Biological $E_{\beta\gamma}$	
0	100	100	1.0
0.16 + 1.2	9.27	25	2.69
0.32 + 1.2	5.65	7.5	1.33
0.50 + 1.2	4.05	3.0	0.74
0.75 + 2.4	3.16	1.6	0.50
1.00 + 2.4	2.94	1.19	0.40
2.00 + 2.4	2.78	0.90	0.32

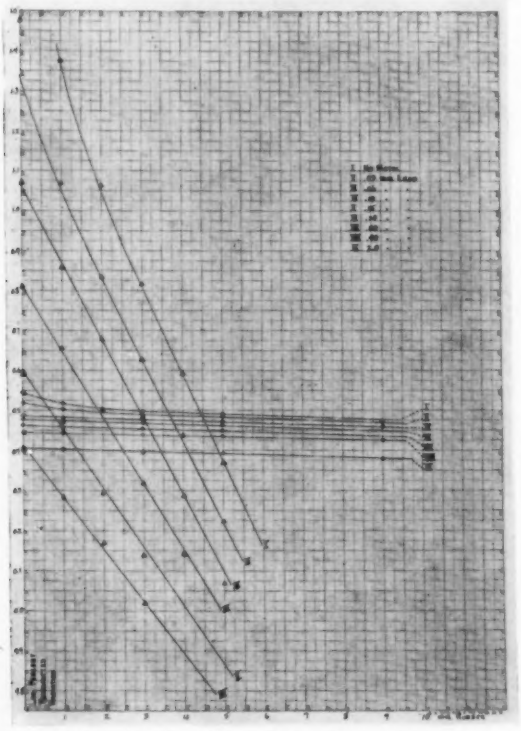

FIG. 7. Absorption in rubber of β and γ radiation transmitted by different thicknesses of lead. Corrected for scattered radiation.

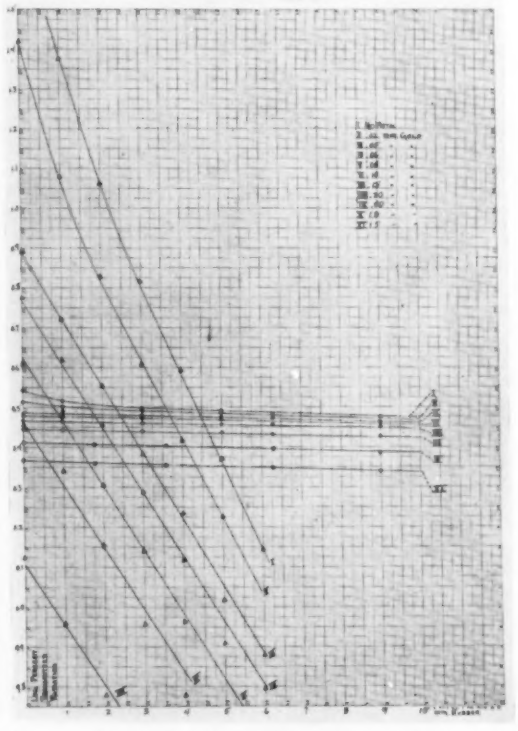

FIG. 8. Absorption in rubber of β and γ radiation transmitted by different thicknesses of gold. Corrected for scattered radiation.

rays are easily absorbed, while the gamma rays are much more penetrating, so to produce equal effects the incident gamma radiation would have to be more intense. Although the gamma rays do vary somewhat in quality, this variation is not enough to take into consideration in the present problem. With the beta rays, however, the case is different. The average quality of the beta rays transmitted by a thin filter will be very different from that coming through a somewhat thicker one.

Taking into account these two factors, quantity and quality, we may consider the effect produced by the total radiation as the sum of the effects due to the beta and gamma radiations separately. Let us denote by E_β and E_γ the absorbed radiation, or whatever is responsible for the biological effects due to the beta and gamma rays respectively, and by $E_{\beta\gamma}$ that responsible for the total effect. That is

$$E_\beta + E_\gamma = E_{\beta\gamma} \qquad (1)$$

The skin doses for the different brass filters have been determined in millicurie-hours for a definite set of conditions. This being the case, they are inversely proportional to the effective radiation, or

$$\frac{1}{\text{mc-hr.}} = mE_{\beta\gamma} \qquad (2)$$

where m is a constant of proportionality. Since we are interested only in relative values, and m depends only on the units

chosen to express the values, we need not consider it, and it will be omitted.

Now let us denote by I_β and I_γ the intensities of ionization due to beta and gamma rays, as measured by the instrument used. Since the quality of the gamma rays does not change much, and Friedrich and Kroenig have shown that for penetrating radiation, ionization measurements may be used as a basis for biological dosage, we may assume

$$E_\gamma = kI_\gamma \qquad (3)$$

where k is a constant for all filters.

For any filter I_β and I_γ have been determined by our electroscope readings. Our problem is to set up such relationships that E_β and E_γ, and hence the millicurie-hour dose, can be determined.

If in Equation (3) k were known, E_γ could always be found from the value of I_γ determined in our experiments. Now, since for 2 mm. of brass the transmitted beta radiation is zero, that is, $I_\beta = 0$, for this case Equation (1) becomes

$$E_{\beta\gamma} = 0 + E_\gamma$$

and Equation (2) becomes

$$\frac{I}{\text{mc-hr.}} = E_\gamma$$

In this case the millicurie-hour dose is 830, whence $E_\gamma = \frac{I}{830} = 0.00120$. For this filter $I_\gamma = 2.78$ (Table II) according to our experiments. Therefore Equation (3) becomes

$$0.00120 = 2.78\ k \text{ or}$$
$$k = 0.00043.$$

Then knowing I_γ for any filter, E_γ may be obtained simply by multiplying I_γ by 0.00043. That is

$$E_\gamma = 0.00043\ I_\gamma \qquad (4)$$

The relation between E_β and I_β is not so simple. Since the quality of the beta rays changes greatly with the filter, this must be taken into account. We can, however, now obtain E_β for any brass filter, using our erythema doses and our ionization measurements, for Equation (2) gives $E_{\beta\gamma}$, Equation (4) gives E_γ, and

$$E_\beta = E_{\beta\gamma} - E_\gamma$$

These values for E_β are listed in Table III.

TABLE III

E_β AND E_γ FOR BRASS FILTERS

Filter Mm. Brass Plus Mm. Rubber	Dose Mc-hr.	$E_{\beta\gamma}$	I_γ	$E_\gamma = kI_\gamma$	$E_\beta = E_{\beta\gamma} - E_\gamma$
0	7.5	0.1333	3.50	0.00151	0.1318
0.16 + 1.2	30	0.0330	3.12	0.00134	0.0317
0.32 + 1.2	100	0.0100	3.04	0.00131	0.0087
0.50 + 1.2	250	0.0040	3.00	0.00129	0.00271
0.75 + 2.4	475	0.0021	2.96	0.00127	0.00083
1.0 + 2.4	630	0.00159	2.91	0.00125	0.00034
2.0 + 2.4	830	0.00120	2.78	0.00120	

Table IV shows how the relation between E_β and I_β varies with increasing filter. Since no constant ratio exists between these two, in order to find one when the other is known it is necessary to plot a curve, such as the one in Figure 9. From this, for any value of I_β the corresponding value of E_β can be read.

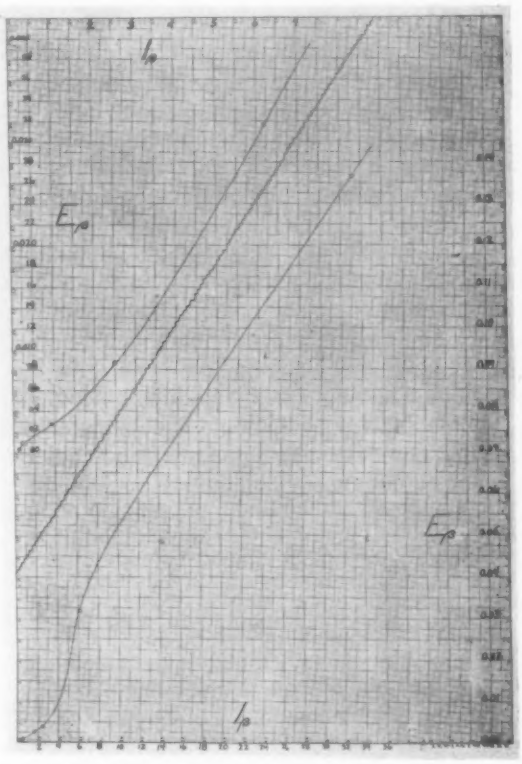

FIG. 9. Relation between I_β and E_β (the upper curve is an enlargement of the first part of the lower one).

TABLE IV
RELATION BETWEEN E_β AND I_β FOR BRASS FILTERS

Filter Mm. Brass Plus Mm. Rubber	E_β (Table III)	I_γ (Curves)	Ratio E_β/I_γ
0	0.1318	33.2	0.00396
0.16 + 1.2	0.0317	6.20	0.00512
0.32 + 1.2	0.0087	2.51	0.00347
0.50 + 1.2	0.00271	0.96	0.00282
0.75 + 2.4	0.00083	0.24	0.00346
1.00 + 2.4	0.00034	0.06	0.00570
2.00 + 2.4			

We have now shown how it is possible to obtain E_β and E_γ for any of the filters studied, and by Equations (1) and (2)

$$E_\beta + E_\gamma = E_{\beta\gamma}$$

$$\frac{1}{E_{\beta\gamma}} = \text{mc-hr.}$$

It must be borne in mind that these equations hold good only for tubular applicators of effective length 14 mm., placed so that the center of the tube is 2 cm. from the skin. So far we have not discussed applicators of any other size or distance of application. Methods of handling these cases will be discussed later, but first examples will be worked out to illustrate the use of the above equations.

Example 1. To determine the erythema dose for a silver tube 0.2 mm. thick, in a rubber tube 1.0 mm. thick, the *center* of the tube being at a distance of 2 cm. from the skin. From Figure 6, (beta and gamma ray curves for silver)

$\text{Log } I^*_\beta = 0.398$ $\qquad$ $\text{Log } I_\gamma = 0.483$

$I_\beta = 2.50$ $\qquad$ $I_\gamma = 3.04$

$E_\beta = 0.0087$ $\qquad$ $E_\gamma = 0.00131$

(from Figure 9)

$$E_{\beta\gamma} = E_\beta + E_\gamma = 0.0087 + 0.00131 = 0.0101$$

$$\text{mc-hr.} = \frac{1}{0.0101} = 99$$

That is, 99 millicurie-hours will produce on the average patient the effect we have called an erythema.

As has been already stated, the definition of an erythema varies widely. However it makes no difference what the erythema dose really is, all the relations here developed hold true. All that we have said is that, measured by biological effects, the effective radiation transmitted by the filters studied is proportional to the values of $E_{\beta\gamma}$. If the dose is known for any filter under the conditions of this experiment (tube 14 mm. long, 2 cm. from the skin), the dose which will give the same effect for any other filter may be found by direct comparison.

Example 2. If the dose used in a certain treatment is 1000 mc-hr. for a silver tube 0.5 mm. in wall thickness, enclosed in 2 mm. of rubber, what dose would give the same surface effect if given with a platinum tube 0.5 mm. thick, in the same rubber? It is necessary first to find for each filter the millicurie-hour dose which will produce our standard erythema on the skin of the average patient.

From the curves for silver, Figure 6:

$\text{Log } I_\beta = 9.322$ $\qquad$ $\text{Log } I_\gamma = 0.474$

$I_\beta = 0.21$ $\qquad$ $I_\gamma = 2.98$

$E_\beta = 0.0008$ $\qquad$ $E_\gamma = 0.00128$

$$E_{\beta\gamma} = 0.0008 + 0.00128 = 0.00208$$

$$\frac{1}{E_{\beta\gamma}} = \frac{1}{0.00208} = 480$$

That is, the dose for our erythema would be 480 millicurie-hours. From the curves for platinum, Figure 8:

$\text{Log } I_\gamma = 0.440$

$I_\gamma = 2.76$

$E_\beta = 0^*$ $\qquad$ $E_\gamma = 0.00119$

$$E_{\beta\gamma} = E_\gamma = 0.00119$$

$$\frac{1}{E_{\beta\gamma}} = \frac{1}{0.00119} = 840$$

That is, 840 millicurie-hours would be our dose. Then the ratio of

$$\frac{\text{Dose for platinum tube}}{\text{Dose for silver tube}} = \frac{840}{480}.$$

That is, the millicurie-hour dose for the platinum tube should be $^{840}/_{480}$ or 1.75 times that for the silver tube. This ratio holds for stronger or weaker doses as well as for our particular erythema dose.† In the problem outlined, the dose used with the silver tube was 1000 millicurie-hours. The corresponding dose for the platinum tube is $1000 \times 1.75 = 1750$. If

* When the logarithm of a quantity is known, the value of the quantity is readily found from any table of logarithms.

* We have seen that for this thickness of platinum there is no beta radiation.

† This is because in the comparison of a new filter with our standard brass filters the relative proportion of effective beta and gamma radiation is not very different.

the dose for the silver tube had been 500 millicurie-hours, that for the platinum would have been $500 \times 1.75 = 875$.

TABLE V

"EFFECTIVE" RADIATION FROM DIFFERENT FILTERS UNDER THE SAME CONDITIONS OF APPLICATION; (TUBE,—EFFECTIVE LENGTH 14 MM., CENTER OF TUBE 2 CM. FROM SKIN). SHOWING ALSO "EFFECTIVE" BETA AND GAMMA RADIATION FOR IONIZATION AND ERYTHEMA EFFECTS

Filter							
Metal, Mm.	Rubber, Mm.	I_β	I_γ	E_β	E_γ	$E_{\beta\gamma}$	Erythema Dose, Mc-hr.
Gold, Platinum, Platinum-iridium, or Gold-platinum							
0.02	1.0	11.98	3.17	0.0670	0.00136	0.0684	14.6
0.05	1.0	5.26	3.03	0.0254	0.00130	0.0267	37.5
0.10	1.0	2.19	2.99	0.0072	0.00128	0.0085	118
0.20	1.0	0.59	2.91	0.0016	0.00125	0.00185	540
0.50	2.0	.....	2.76	.....	0.00119	0.00119	840
1.0	4.0	.....	2.50	.....	0.00108	0.00108	925
1.5	4.0	.....	2.27	.....	0.00098	0.00098	1020
Lead							
0.03	1.0	11.67	3.17	0.0651	0.00136	0.0665	15.0
0.06	1.0	7.20	3.06	0.0380	0.00132	0.0393	25.5
0.10	1.0	4.52	3.02	0.0205	0.00130	0.0218	46
0.20	1.0	1.92	2.96	0.0081	0.00126	0.0094	106
0.50	2.0	0.17	2.86	0.0006	0.00123	0.00183	550
0.90	2.0	.....	2.75	.....	0.00118	0.00118	850
1.0	2.0	.....	2.72	.....	0.00117	0.00117	855
1.5	4.0	.....	2.61	.....	0.00112	0.00112	890
2.0	4.0	.....	2.46	.....	0.00106	0.00106	945
Silver							
0.05	1.0	9.13	3.16	0.0510	0.00136	0.0524	19.1
0.10	1.0	5.59	3.05	0.0277	0.00131	0.0290	34.5
0.20	1.0	2.50	3.04	0.0087	0.00130	0.0101	99
0.50	2.0	0.21	2.98	0.0008	0.00128	0.00208	480
1.0	2.0	0.03	2.85	0.00002	0.00122	0.00124	810
1.1	2.0	.....	2.82	.....	0.00121	0.00121	830
Brass or Copper							
0.05	1.0	11.2	3.25	0.0630	0.00140	0.0644	15.5
0.10	1.0	8.92	3.15	0.0538	0.00135	0.0552	18.1
0.20	1.0	5.47	3.06	0.0269	0.00132	0.0282	35.5
0.40	1.0	1.96	3.04	0.0062	0.00131	0.0075	138
0.50	1.0	1.03	3.03	0.0028	0.00129	0.0041	244
0.75	2.0	0.26	2.97	0.0008	0.00127	0.00207	483
1.0	2.0	0.08	2.91	0.0002	0.00125	0.00145	690
1.5	2.0	0.04	2.87	0.00002	0.00123	0.00125	800
2.0	2.4	.....	2.78	.....	0.00120	0.00120	830

The millicurie-hour doses for our standard erythema for a number of filters have been calculated and are given in Table v. Here are also listed the "effective" beta, gamma, and total radiation for each filter, so that a comparison of the quality may be made.

Example 3. The millicurie-hour dose for 0.03 mm. lead plus 1 mm. rubber is 15.0 mc-hr. The same dose will be given with 0.05 mm. brass and 1.0 mm. rubber in 15.5 mc-hr. The difference between these doses is 2½ per cent, that is, the effective radiation is nearly the same in the two cases. How do the quantities of beta and gamma radiation differ? E_β, the effective beta radiation, is 0.0651 for the lead and 0.0630 for the brass, that is, the lead has 3 per cent more. E_γ, the effective gamma radiation, is 0.00136 for the lead and 0.00140 for the brass, that is, the lead has 3 per cent less. This illustrates the possible difference in quality for filters which give nearly the same total radiation.

This table also illustrates the relative importance of the beta and gamma radiation in producing the biological effects and the ionization in the particular instrument used.

Example 4. In the calculation for 0.10 mm. platinum plus 1.0 mm. rubber the beta radiation effective in producing the ionization (I_β) is a good deal less than the gamma radiation thus effective. That is, $I_\beta = 2.19$; $I_\gamma = 2.99$. But the beta radiation is much more effective in producing the skin erythema. $E_\beta = 0.0072$; $E_\gamma = 0.00128$. That is, the beta radiation has relatively more influence on the skin effect than on the ionization.

The list of skin doses also offers a means of comparing the effective radiation from any two applicators under the same conditions. The doses given are for tubes of different filtration, 2 cm. from the skin. However the ratio of millicurie-hour dose for any applicator of one filter to millicurie-hour dose to produce the same surface effect with a like applicator of another filter will be the same as for the corresponding filters in the table.

Example 5. Compare the radiation from two "tray" applicators of the same size, one having a filter of 2 mm. brass and the other 2 mm. of lead, each with the appropriate secondary filter. Two mm. of

lead requires more rubber to remove the secondary radiation than 2 mm. of brass, about 4 mm. should be used. For this reason, with the larger thicknesses of lead and platinum the larger secondary filters have been used in calculating the table. The millicurie-hour dose for 2 mm. brass plus 2.4 mm. rubber is 830, that for 2 mm. lead plus 4 mm. rubber is 945. So the dose for the lead tray would be $^{945}/_{830}$ times that for the brass one. If we know that the erythema dose for the brass tray at a certain distance of application, say 3 cm., is 2000 mc-hr., to produce the same erythema the dose for the lead tray should be $2000 \times {}^{945}/_{830}$ or 2,280 mc-hr.

It will be seen that this enables us to determine the millicurie-hour doses for applicators of the *same type* but having different filtration, both as regards material and thickness of filter. The data given in a previous publication[4] enable us to determine the millicurie-hour dose for any applicator having a brass filter. With the data supplied in that paper and the present paper we can calculate the dose for any practical applicator of the filters considered.

Example 6. What is the erythema dose for a plaque 2 cm. square, having a filter of 0.5 mm. silver and 2 mm. rubber, to be used 1 cm. from the skin? From Table v this silver filter is "equivalent" to 0.75 mm. brass. We know also from this table that the skin dose for a tube having this filter, at a distance of 2 cm., is 480 mc-hr. Therefore when we have found the relation between this tube and the plaque we can obtain the dose for the latter. Now it is necessary to refer to the previous paper. Example 4 of that paper gives the method for comparing the effective radiation from two applicators of the same filter but different sizes and distances of application. Following the method there outlined we find that the dose for a plaque 2 cm. square, with a filter of 0.75 mm. brass and 2 mm. rubber, 1 cm. from the skin, is 210 mc-hr. Since this brass filter is equivalent to the silver one we are investigating, the dose for it also is 210 mc-hr.

It has not been possible to make clinical checks of many of the doses in Table v. However for a few filters besides the standard brass ones the threshold erythema has been found. These doses were obtained without considering the results found by calculation from this paper. The results are shown in Table VI. In no case is the difference between the calculated and experimental values more than 10 per cent. Therefore it is evident that the doses obtained from the data presented in this paper can be safely used in clinical work, and will have the desired accuracy.

TABLE VI

COMPARISON BETWEEN CALCULATED AND EXPERIMENTAL SKIN DOSES

Filter	Mc-hr. Calc.	Mc-hr. Exp.	Ratio Calc./Exp.
0.05 mm. gold plus 1.2 mm. rubber	41	38	1.08
0.5 mm. gold plus 2.4 mm. rubber	850	830	1.02
0.06 mm. lead plus 1.2 mm. rubber	28	30	0.93
0.5 mm. silver plus 2.4 mm. rubber	590	630	0.94

There is a simple way of determining approximately equivalent filters by comparing the thicknesses of metals which give the same ionization measurements. At the beginning of this paper we stated that, particularly for thin filters, equal ionization effects could not be used to predict equal biological effects. However values thus obtained would not differ radically, and this may be used as a rough check to detect gross errors in calculation. From Figure 2 we find for any filter the percentage of transmitted radiation, and then the thickness of brass which will give the same ionization. In Figure 10 we have plotted skin doses for different thicknesses of brass, from Table III, so we can look up here the dose for the brass "equivalent" of the filter under investigation. The doses for the brass filters were determined with appropriate secondary filters of rubber. In making a comparison of doses from "equivalent" filters the thickness of rubber would be about the same in the two cases, so that it is possible to use this curve for the check.

Example 7. Check the dose given in the table for 0.2 mm. lead and 1.0 mm.

rubber. On Figure 2, follow the line for 0.2 mm. metal up until it cuts the curve for lead. From this point of intersection follow a horizontal line across until it cuts the curve for brass. The points where this horizontal line intersect the metal curves indicate thicknesses which produce the same ionization effects. Following a vertical line down from the intersection with the brass curve, we find that the thickness indicated is 0.39 mm. Now in Figure 10, starting at a brass thickness of 0.39 mm. and drawing a vertical line up to the curve, we find that the skin dose for this thickness of brass is 155 mc-hr. The dose in the table is 106. This is a difference of 50 per cent, showing that there is no gross error in the table, but also showing that for such thin filters it would be very unwise to base skin doses on total ionization effects. For thicker filters the difference is much less. For instance the dose for 1.0 mm. silver obtained in this fashion is 760 mc-hr., as against 810 in the table, a difference of only 6 per cent.

In the course of the experimental work certain facts were observed which have a direct practical bearing on the manufacture of applicators. Brass and copper were found to have the same absorbing qualities, within the limits of experimental error, so were gold and platinum. This is to be expected, since for each pair the density and atomic number are very nearly the same. This means that the members of these pairs may be used interchangeably. In the case of gold and platinum this is important from the point of view of cost. Pure gold, however, is so soft that its use is impractical, while the metals commonly used to harden it also reduce its absorption. So we had made up a special alloy of 85 per cent gold and 15 per cent platinum. This proved to be very satisfactory, having the requisite hardness and filtration, and possessing the additional advantage that it could be enamelled with different colors. This is a simple means of identifying individual tubes.

Many of the tubes and needles used at present are made of an alloy of platinum and iridium. The values given for gold or platinum are equally applicable to this alloy, since iridium has very nearly the same density and atomic number as platinum.

SUMMARY

1. The absorption of beta and gamma radiations in several metals has been determined. Then the absorption in tissue or tissue substitute of beta and gamma radiation transmitted by a wide range of thicknesses of these metals has been measured.

2. This has been correlated with biological information obtained from numerous skin tests, using the threshold erythema as an indicator. From this an empirical relation has been worked out between ionization measurements and skin doses for radiation delivered by filters of various metals. It is important to note that, this relation being empirical, any calculations made within the range covered by the experiments will give sufficiently accurate results for practical work.

3. This relation gives a method for determining the erythema dose for any filter, based on the results of physical experiments. The data given enable the radiologist to figure out doses for many filters, (different materials and thicknesses).

4. With the aid of data already published, the determination of millicurie-hour doses can be extended to include

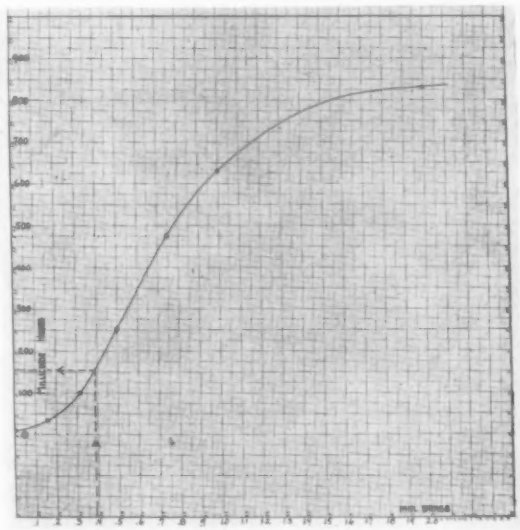

FIG. 10. Erythema dose in millicurie-hours for different brass filters.

applicators of various sizes and shapes, as well as different distances from the skin.

5. Comparisons may be made of the quantity and quality of radiation effective at the skin, delivered by different applicators.

6. A number of examples have been worked out to illustrate the preceding points.

7. A table is given of millicurie-hour doses for many filters, based on the threshold erythema as a standard. (These doses are for a tube 14 mm. long, having its center 2 cm. from the skin.)

8. Certain values calculated from the data here presented have been compared with values determined from skin tests on patients. The results show close agreement.

9. A secondary check on the method and on the results obtained may be made by determining the equivalent brass thicknesses from the metal absorption curves for any desired filter.

In conclusion the writer wishes to acknowledge her indebtedness to Dr. G. Failla, who suggested the investigation of the problem, for his constant interest and many suggestions during the course of the work. We are also greatly indebted to Dr. C. S. Brainin and to Baker and Company, for lending us the silver, gold, and platinum filters, and for making the special gold-platinum alloy.

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METASTATIC MANIFESTATIONS OF HYPERNEPHROMA IN BONE*

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THE pathology of hypernephroma, together with the symptomatology and diagnosis, has been discussed at considerable length in the literature. Comparatively little, however, has been written about the metastases to bone, and it is with this phase of the subject that this paper is concerned.

OCCURRENCE—TRANSMISSION

In October, 1923, Gibson and Bloodgood in an article on hypernephroma reported 5 cases with metastases to bone, and collected 33 cases from the literature. In addition to these, Colmers, MacKechnie, and Broster each report a case of metastasis to the femur; Buschmann one to the spine, and Ryan one to the pelvis. This makes a total of 43 cases to date. Garceau from a compilation of 176 cases of hypernephroma, many with clinical data only, reports bone metastases in 35. In a review of 46 cases of hypernephroma studied at the Massachusetts General Hospital during the past seven years, bone metastases were discovered in only six.

The average age incidence is between forty and sixty, but the disease may occur in childhood. Bevan reports the case of a child who died with "almost the entire skeleton involved." Males are somewhat more commonly affected than females.

Transmission to bone is by way of the blood stream in the majority of cases. In Garceau's series the distribution was as follows: femur 7; vertebrae 7; ribs 6; skull 5; clavicle 2; pelvis 2; humerus 2; scapula 1; jaw 1; tibia 1; metacarpus 1. It is readily seen that the flat bones are most commonly involved; moreover, metastases

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are very uncommon below the proximal end of the humerus and femur. A very convincing explanation for this distribution is given by Piney.

At birth all the bones of the skeleton, except the cranium, contain red marrow. As age advances, fatty tissue appears in the marrow, but is not present in equal amounts in all the bones. The vertebrae, sternum, ribs, and innominate bones contain red marrow throughout life, with only microscopical amounts of fat. During childhood, the marrow of the long bones remains red, but fat is found in appreciable amounts microscopically. Before the age of puberty, fat is seen macroscopically. This conversion of red marrow into fatty marrow is completed more quickly in the distal bones. Finally there remains only a patch of red marrow at the upper end of each humerus and femur, and this persists throughout life.

In the fatty marrow, the blood channels are well formed, but the red marrow is essentially a tissue consisting of innumerable blood channels with extremely thin walls. It is obvious that the great widening of the stream bed at the junction of the fatty with the red marrow must involve a considerable decrease in the rate of flow in this area. Here we have ideal conditions for the deposition of emboli of cancer cells which may be floating in the blood stream. Just as margination of the leucocytes occurs in an inflammatory area, with its dilated capillary bed, so it is reasonable to suppose that there may be a similar margination of cancer cells in the red marrow. Thus we should expect the location of blood borne metastases to conform to the anatomical distribution of the red marrow, and this it does in most instances.

CASE REPORTS

Ten cases have been collected which are classified according to the location of the principal metastases.

STERNUM (1 case)

Case 1. West surg. #262928. F. L. M. male, aged fifty-nine. First admitted to the Massachusetts General Hospital May 13, 1924, with a diagnosis of aneurysm.

Present illness began about two years ago, when patient was seized with severe pain in the region of the upper portion of the sternum. About two months later there appeared a small lump about the size of a walnut at the mid portion of the sternum. This grew slowly but steadily, till in four months it had attained the dimensions of a good-sized peach. Antiluetic treatment was given by a local physician for two months, but without benefit. During the past year the tumor has not grown perceptibly, but has taken on a definitely expansile pulsation, and gives considerable pain. No cachexia, or loss of weight.

Past history essentially negative. No symptoms referable to the kidney, except slight nocturia during the past year. No hematuria. No history of venereal disease.

FIG. 1. Hypernephroma of sternum simulating aneurysm.

Family history unimportant.

Examination revealed a large, dome-shaped tumor 10 × 12 cm. over the upper part of the sternum (Fig. 1). It was exactly in the midline, covering the area from the insertion of the fourth rib up to the interclavicular notch, and extending on both sides over the costal cartilages. It pulsated synchronously with the heart, and transmitted a systolic murmur which was propagated along the great vessels, and into the right side of the neck. This murmur could not be heard over the heart itself. The pulsation was definitely expansile.

Urine examination negative, except for occasional hyaline casts; no blood. Blood

count essentially normal. Wassermann test negative.

Clinically, a very justifiable diagnosis of aneurysm was made. Roentgenoscopic study of the chest showed the aortic arch to be normal in size and shape. No mediastinal tumor was made out. A plate of the chest taken in the lateral position, showed the outline of the sternum fairly well. There was some inward bulging of its inner surface, but normal lung could be seen between the sternum and the great vessels. The bone in the upper portion of the sternum was partially destroyed, and this area was continuous with the shadow of the tumor. Diagnosis, malignant tumor of the sternum. In spite of the roentgen-ray findings, surgery was decided upon, and preparations made for a wiring operation, in case the tumor proved to be aneurysm.

Operation, May 21, 1924.

A large vascular tumor of the sternum itself, not connected with the great vessels, was found. It was impossible to extirpate the tumor on account of the excessive hemorrhage. By weighing the sponges it was estimated that 2,000 c.c. of blood were lost. A specimen removed for pathological examination proved to be hypernephroma.

Not wishing to arouse the patient's apprehension, further roentgenographic study of the skeleton and kidneys was not carried out. There was no clinical evidence of other metastases.

After a slow recovery the patient was referred for roentgen treatment. There was still a large pulsating tumor of the sternum with several bloody, draining sinuses. A massive dose of high voltage, copper filtered radiation was given directly over this area, and this dose repeated in a month. A most gratifying, and we must admit unexpected result was obtained. The tumor shrank to one-half its original size, the sinuses healed, pain disappeared to a large extent, the patient gained weight, and finally went back to work, very greatly improved. At last observation, on Dec. 22, 1924, the following note was made: "There is no appreciable change in the size or appearance of the tumor over the sternum. General condition is good."

On reviewing the literature we find that in 1896, Paget in his book on the "Surgery of the Chest" calls attention to large sarcomatous growths of the sternum which are frequently confounded with aneurysm. Many of these were probably metastatic hypernephromata.

Three cases of hypernephroma of the sternum have been reported, two by MacLeod and Jacobs, one by Eshner. Clinically these three cases were aneurysm. Two of them were examined by the roentgen ray, which absolutely ruled out aneurysm.

CLAVICLE (1 case)

Case 11. Third Surgical #263225. J. M., male, aged forty-two. Admitted to Massachusetts General Hospital May 27, 1924, complaining of pain and swelling in the left shoulder.

There had been some weakness of the left shoulder about four years before, but this had cleared up entirely. Six months previous to admission, a small lump appeared just medial to the mid portion of the clavicle and was accompanied by a dull ache. The tumor grew steadily until it attained the size of a small orange. For about six months there had also been some tenderness on pressure in the region of the right sterno-clavicular junction, together with a very small swelling.

The past history was negative except for anorexia and loss of weight during the past two years. No renal colic, or hematuria.

Examination revealed a tumor about 12 × 6 cm. occupying the region of the outer portion of the left clavicle. This was rather soft, fluctuant, and gave a definite, expansile pulsation. The skin over the tumor was normal. On auscultation there was a definite bruit over the whole tumor. Some pain on motion, but no interference with motion. The circulation in the arm was normal, and the blood pressure the same on both sides. At the inner end of the right clavicle was a hard, non-tender, bony swelling; also a similar, but smaller tumor in the upper portion of the manubrium.

There were no masses or tender areas in the abdomen.

The urine was negative for Bence-Jones protein, and contained no blood, except after cystoscopic examination. Wassermann reaction negative. Blood count showed a moderate secondary anemia.

Roentgen-ray examination showed complete destruction of the outer third of the left clavicle, with invasion of the soft tissues (Fig. 2). There was a similar, though less extensive process in the right clavicle. In the skull were a number of small, punched-out areas of destruction (Fig. 3). The lungs were clear, and there was no other evidence of bone involvement. A pyelogram showed an irregularity of the calyces of the right kidney, with a large mass

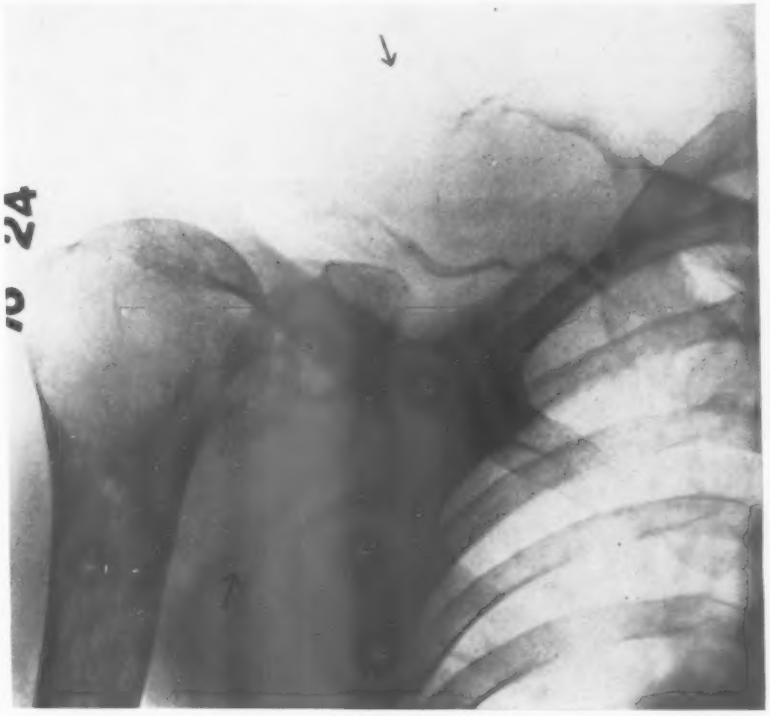

FIG. 2. Destruction of greater portion of clavicle; also involvement of scapula.

FIG. 3. Punched out areas in skull.

pressing upon, and displacing the ureter. Although no biopsy was done, it seems justifiable to make a diagnosis of hypernephroma with bone metastases in this case.

It was decided to try the effect of roentgen treatment upon the largest of these metastases, that in the left clavicle. Massive doses of short wave roentgen rays reduced the tumor to one-third its original size in about three months. The patient, however, is slowly, but steadily losing ground. The last observation was on January 10, 1925. Roentgen examination showed a considerable increase in the destructive areas above described, and also the appearance of a similar process in the upper portion of the humerus on both sides.

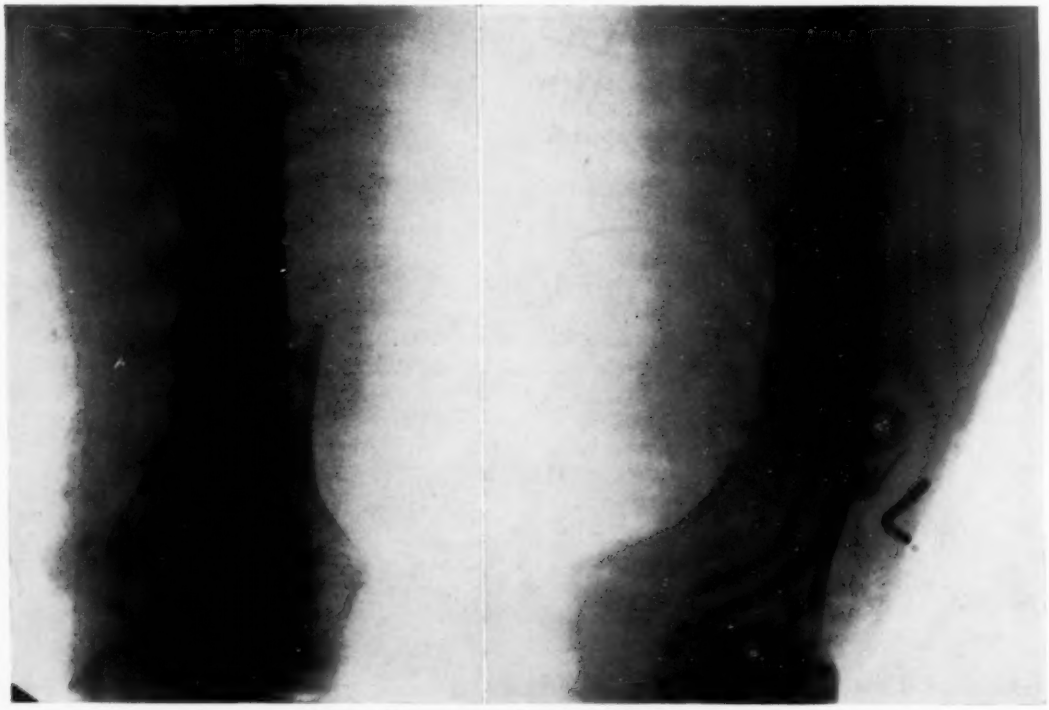

FIG. 4. Spontaneous fracture of both femora.

FEMUR (3 cases)

Case III. P. H. S. #11858. E. J. A., aged, sixty-six.

This patient had a right nephrectomy at the Massachusetts General Hospital, Dec. 3, 1913. There was a large hypernephroma involving the lower pole (pathological confirmation).

Five months later, May 3, 1924, while the patient was getting out of bed, both legs suddenly collapsed under her. A portable roentgen-ray examination on the following day, showed a pathological fracture of the lower ends of both femora (Fig. 4). The patient died May 20, with signs of generalized metastases. (By courtesy of Dr. A. W. Allen.)

Case IV. L. B., elderly female.

During the summer of 1924 the patient suffered from rheumatic pains in the left leg, worse between the knee and hip. In October, 1924, she had a sudden, very sharp, excruciating pain in the left thigh and fell to the floor. It was very evident that there was a fracture, which clinically was thought to be pathological. General physical examination was essentially negative. The kidneys could not be palpated. Roentgen examination showed a pathological fracture of the femur (Fig. 5). Patient died a week later. Autopsy revealed a hypernephroma of the right kidney with metastases to the right perirenal fat, left adrenal, and left femur. (By courtesy of Dr. R. H. Miller and Dr. A. W. Allen.)

Case V. W. S. #265238. H. W., female, aged fifty-four.

Entered the Massachusetts General Hospital Sept. 9, 1924, with the complaint of a lump in the right flank. A similar lump had appeared in this location three months previously, and was excised by her local physician. The specimen on pathological examination was diag-

nosed as hypernephroma. There was a prompt recurrence of the tumor. About this time there developed a hacking, non-productive cough, with pain in the lower chest. More recently a lump appeared over one of the ribs, and another lump in the groin. General malaise and loss of weight.

The past history was negative. No symptoms referable to the kidney.

On examination there was found a slightly tender mass located within the skin and subcutaneous tissue of the right flank. In the sixth rib anteriorly on the right, was a fusiform swelling about one inch long; in the right groin, a cherry-sized lymph node. The left chest was flat, with absence of breath sounds. In the abdomen was palpated a large nodular mass, apparently connected with the left kidney. Urine showed red blood cells in the sediment.

FIG. 5. Pathological fracture of femur.

Roentgen examination revealed a destructive process in the mid portion of the shaft of the left femur (Fig. 6). No other bony involvement. There was irregularity of the outline of the left kidney. A homogeneous dullness involved almost the entire left chest.

Diagnosis, hypernephroma with metastases to bones and lung. The patient died Nov. 16, 1924, two months after admission to the hospital.

HUMERUS (3 cases)

Case VI. G. U. #243533. D. D., male, aged thirty-six.

Admitted to the Massachusetts General Hospital June 9, 1921, with the complaint of blood in urine, with some difficulty in passing urine.

There had been attacks of hematuria for several months. These finally ceased, and patient was free from symptoms until a month before admission. At this time hematuria again appeared and persisted.

FIG. 6. Small area of destruction in femur.

The physical examination was essentially negative. No masses to be palpated in the abdomen. Cystoscopic examination revealed a large amount of pus coming from the right ureter.

Pyelogram showed an enlarged right kidney, with an encroachment on the area of the pelvis. No roentgenograms of the bones were made.

Operation, June 30, 1921. Right nephrectomy. Kidney found to contain a large hypernephroma (confirmed by pathological examination).

Recovery was uneventful, and the patient was discharged.

On August 2, 1921, approximately a month after operation, the patient returned with a

pathological fracture of the upper third of the humerus (Fig. 7). Roentgen examination showed an area of bone destruction, not only at the site of the fracture, but also in the upper portion of the femur, and in the skull. Death occurred Dec. 28, 1922.

The metastases in this case were in all probability present before operation, being first revealed by a pathological fracture.

FIG. 7. Pathological fracture of humerus.

This emphasizes the necessity of a complete roentgenographic study of the skeleton in all cases of suspected hypernephroma.

Case VII. Registry Bone Sarcoma #150. J. T. W., male, aged fifty-nine. Admitted to hospital Feb. 9, 1922. Thirteen months before, there had been trauma to the right shoulder. A short time afterward a small lump appeared at the site of injury, and grew slowly in size. Some pain. Six months later, pain appeared in the left shoulder, and this was shortly accompanied by swelling. The tumor of the right shoulder had increased to the size of an orange when patient came under observation. Roentgen examination of this region showed an area of diminished density at the junction of the outer and middle thirds of the right clavicle. Roentgenogram of the left shoulder revealed entire absence of the upper end of the humerus (Fig. 8), with areas of destruction in the acromion, glenoid, and outer end of the clavicle. The left arm was amputated. The tissue was examined by Ewing, Wolbach, and Mallory. All agreed on hypernephroma.

The patient died a month after operation.

Case VIII. Registry Bone Sarcoma #148. A. H., male, aged thirty-nine. First seen March 9, 1922. Complaint of pain in the left arm, shoulder, and chest, of nine months' duration. During the past week there had been loss of function of the left arm, some loss of weight.

Examination showed a fusiform swelling at the junction of the middle and upper thirds of the humerus, which was not particularly tender. Roentgen examination revealed an area of bone destruction just above the mid portion of the shaft of the left humerus. Through its center was a pathological fracture, with beginning callus formation (Fig. 9). Stereoscopic examination of the thorax showed an area of destruction in the fifth rib on the left near its spinal attachment. Roentgenographically, the left kidney was seen to be considerably enlarged, but there were no clinical signs referable to the kidney.

Operation March 13, 1922. Humerus found to be fractured. The cortex was of egg-shell thickness, with a cavity filled with granular, necrotic tissue. This was thoroughly cleaned out, and tissue submitted for examination. Bloodgood, Ewing, Wolbach, Wright, and Mallory concurred in a diagnosis of hypernephroma. Death five months following operation.

SPINE (1 case)

Case IX. O. P. D. #443970. M. H., female, aged thirty-two.

Patient was first seen in the out patient department of the Massachusetts General Hospital June 24, 1921. For about two years she had suffered from pain in the back. Six months before entry a swelling appeared in the upper lumbar region. Roentgen examination revealed almost complete destruction of the second lumbar vertebra, with numerous small vacuolated areas in the ribs (Fig. 10). There were also several small areas of destruc-

tion in the skull. The long bones were all negative. Pyelogram showed definite abnormality in the outline of the right kidney pelvis. Unfortunately this patient did not return for further examination, so that the data are very incomplete. A provisional diagnosis of metastatic hypernephroma was, however, made.

Several cases of metastases to the spine have been reported. Gibson's case showed almost complete destruction of the lumbar spine, with the exception of the second lumbar vertebra, which strangely enough remained intact, and showed increased density, rather than destruction. Bullowa described in detail a large pulsating tumor involving several vertebrae of the thoracic spine. The patient also showed blood in the urine, and a diagnosis of metastatic hypernephroma was made. The patient died with symptoms of marked spinal cord involvement, and autopsy proved the diagnosis to be correct.

FIG. 8. Entire upper end of humerus destroyed by hypernephroma.

TIBIA (1 case)

Case x. Registry Bone Sarcoma #154. E. R., female, aged ten.

In February, 1921, the patient fell and injured the right knee. About two months later pain and swelling appeared just external to the tubercle of the right tibia. This area was incised, but nothing was found. Pain, however, still continued, and a small, slightly pulsating swelling persisted. Roentgen examination revealed destruction of the outer two-thirds of the head of the right tibia (Fig. 11). No involvement of the epiphyseal line; no new bone formation. A diagnosis of osteogenic sarcoma was made. Amputation was advised, but refused. Shortly afterward, however, the lesion was curetted. In February, 1922, approximately a year after the first appearance of symptoms, a recurrence was observed at the site of curettement, and the right thigh was amputated.

Considerable discussion as to the nature of this tumor arose among the pathologists. Bloodgood and Wright were most strongly in favor of hypernephroma. Ewing's diagnosis was endothelioma; Wolbach's, giant cell tumor of the xanthoma type, which he believes non-malignant. The tumor was temporarily classified as hypernephroma. The patient recovered from the operation, and was well a year later.

This case presents several interesting features. It illustrates the difficulty which may be encountered in the pathological

diagnosis. The situation of the metastasis, distal to the femur, is also noteworthy. This location, however, is well in accord with Piney's theory of distribution. At ten years we should expect to find red marrow still present in the upper end of the tibia.

FIG. 9. Pathological fracture of humerus. Note that callus formation obscures the picture of a purely destructive process which is ordinarily seen in hypernephroma.

DIAGNOSIS

The diagnosis of hypernephroma metastases in bone is by no means easy. A few points of value, however, may be mentioned.

The tumor may be very vascular, giving a definitely expansile pulsation, and when located in the sternum may clinically be mistaken for aneurysm. Roentgen examination should definitely rule out aneurysm by the demonstration of a normal aorta, and a clear zone between the sternum and the mediastinal shadow.

The lesion is nearly always a purely destructive one, quickly eroding the bone and involving the soft tissues. There is no new bone formation. One exception to this rule, however, has been reported by Albrecht. This case showed a hyperplastic type of metastasis in the occipital bone, which was confirmed by very complete pathological examination. The author concludes that hypernephroma may pro-

FIG. 10. Almost complete destruction of second lumbar vertebra.

duce an osteoplastic type of metastasis, similar to that found in carcinoma of the breast, prostate, and thyroid.

Spontaneous fracture through a metastasis may complicate the picture of a purely destructive lesion by reason of the new bone laid down in the process of repair (Fig. 9).

Metastases are usually multiple, but there are several authentic cases showing a single metastasis only.

Any bone in the body may be involved, but metastases distal to the humerus and

femur are infrequent. The disease may occur at any age, but is most common between forty and sixty. Any patient in the "third age period" showing a purely destructive process in the bone should be thoroughly investigated for hypernephroma, both clinically and roentgenologically.

Foremost among those conditions from which metastatic hypernephroma must be differentiated is primary osteogenic sarcoma. In cases of single metastases with no signs pointing to kidney involvement, this differentiation is practically impossible without removing a specimen for microscopic study.

Hypoplastic metastases from other sources may be confused with hypernephroma, in which event a careful search for the primary focus is necessary.

Ewing's tumor (endothelioma) may be multiple, and is a destructive type of malignancy. The few cases which have come under our observation have been single lesions.

Multiple myeloma produces small, vacuolated areas in the bone; the cortex is not often eroded, and not infrequently there is involvement below the elbow and the knee.

Osteitis fibrosa cystica produces areas of decreased density within the bone, with expansion but not erosion of the cortex. Involvement of the legs, forearms, hands and feet is not infrequently observed.

TREATMENT

The problem of treatment is an interesting one.

One of Albrecht's patients returned four years after a nephrectomy for hypernephroma, with a single apple-sized metastasis in the scapula. The scapula was radically excised, and ten years later the patient was still well and apparently free from disease.

Colmers and Israel also report favorable results from nephrectomy, together with surgical removal of a single metastasis.

Bevan believes that roentgen radiation has a selective effect on hypernephroma, and reports a most astonishing disappearance of the tumor in one of his cases. It has been our experience, however, that this disease is extremely resistant to irradiation. Before the advent of deep therapy, a number of cases of hypernephroma were treated at the Massachusetts General Hospital by low voltage, aluminum filtered roentgen rays. Nothing whatsoever was accomplished. One of these cases came under my personal observation. Following a nephrectomy, a metastasis appeared in the soft tissues just above the clavicle. The superficial

FIG. 11. Destructive process in upper end of tibia.

location afforded a very favorable site for irradiation, but the tumor grew steadily and rapidly in spite of moderate doses of aluminum filtered roentgen rays.

With this experience in mind, the first two cases cited were given deep therapy in doses large enough to produce a very marked erythema, followed by tanning and exfoliation of the skin. In both cases there was definite reduction in the size of the tumor, with alleviation of symptoms. It should be emphasized that the dose was

much larger than we are usually accustomed to give.

PROGNOSIS

The prognosis after the appearance of metastases is gloomy. As a rule, the duration of life is a matter of a few months at best. These tumors vary considerably, however, in their malignancy, and some cases have lived five years or more without treatment.

CONCLUSIONS

1. Hypernephroma metastases to bone are rare.
2. There is often no sign of renal involvement, the metastasis being the first symptom which brings the patient to the physician.
3. Metastases are usually multiple, but may be single.
4. Clinically these tumors frequently give an expansile pulsation, and may be mistaken for aneurysm.
5. Roentgenologically the process is practically always a purely destructive one.
6. The location of metastases conforms to the anatomical distribution of the red marrow in the majority of cases.
7. Palliative results may be expected from high voltage roentgen irradiation in massive doses.

The contribution of cases by the Registry of Bone Sarcoma, and by Drs. Arthur W. Allen and R. H. Miller is gratefully acknowledged.

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DISCUSSION

DR. HENRY K. PANCOAST, Philadelphia. It is unfortunate that the metastases of hypernephroma to bone do not present a more characteristic appearance, in order that we may readily differentiate them from other malignant conditions which metastasize, particularly carcinoma.

We have recently had some experience with a case of this kind which is somewhat different from those which have been reported. The patient, a negro laborer, came to us from the surgical out-patient department of the University Hospital for an examination of the forearm. We found an oblique fracture of the upper half of the shaft of the radius, and on further study we found that this was a pathological fracture. There was a tumor of the soft tissues at about the seat of fracture, and also a long scar, which we learned was due to the removal of a similar growth at the Jefferson Hospital three years before. The first growth had been present eight years when removed. We then examined his chest and found evidence of nodular lung metastasis.

The soft tissue tumor was excised and the pathological report was hypernephroma. We then learned on inquiry that the lump removed three years before at the Jefferson Hospital had also been reported as hypernephroma. This would make eleven years from the time the first tumor was noticed until the excision of the

second tumor. No mass has ever been palpated in the abdomen.

The growth in the underlying radius may be of the same nature or may be coincidentally of a different kind. The presence of metastases in the lungs and the fairly good use of the arm at present, with some union, preclude the possibility of determining the exact nature of the bony growth.

Dr. George W. Holmes, Boston. I have been very much interested in this problem, and it seems to me that the important points have been well brought out by Dr. Dresser. The fact that these tumors are so frequently mistaken for aneurysm is a point perhaps that a good many of us do not appreciate, also the difficulty of distinguishing them from primary bone tumors. We hoped, when we undertook this work, to arrive at some definite diagnostic conclusions that would enable us to differentiate them from the other bone tumors, but we were not able to do so except that we were able to state that these tumors are more likely to be multiple.

The treatment of these tumors is also interesting in that we were able to get good results by increasing the dose a little beyond the usual amount. A dose that injures the skin will reduce such a tumor, whereas a dose which does not injure the skin will not reduce it. The skin in one of these cases had necrosed anyway so we did not have to be careful regarding injury. The fact that a good result can be obtained in certain cases by giving a little over the erythema dose is an important point.

Dr. Dresser (closing). There is apparently a considerable variation in the malignancy of these tumors, both locally and after the metastases appear. Cases have been reported in which a hypernephroma has lain dormant in the kidney for a great number of years, and, as Dr. Pancoast illustrates, even after the metastases occur, the duration of life may be comparatively long. I did not have time to go into the case histories of the slides that I have shown you, but as a rule, exitus occurs very shortly after the appearance of the metastases.

URETERAL VARIATIONS WITH ASSOCIATED KIDNEY CHANGES*

BY DOUGLAS J. ROBERTS, M.D.

HARTFORD, CONNECTICUT

THE time is now passing when a surgeon believes that a patient should be operated on for a doubtful gall-bladder, appendix or tube without first carefully excluding pathology in the urinary tract, bearing in mind constantly that a negative urinalysis falls far short of excluding pathology in this important field. The rôle of the ureters is assuming more and more importance, thanks to that pioneer and most enthusiastic student, Hunner, and to Braasch, Eisendrath and others. It is Hunner, however, who ever since 1915 has worked to prove beyond dispute that ureteral strictures from causes other than tuberculosis and lithiasis are frequent findings when properly sought.

A brief anatomical analysis of the ureters shows them to be muscular tubes 25 to 30 cm. in length, the left 1 cm. longer than the right, and both approximately 0.5 cm. in width. Physiologically the function of these ureters is to receive the urine from the pyramids and convey it through propulsion into the bladder. When empty, these tubes are somewhat flattened, the lumen appearing star-shaped on cross section. The circular musculature of the ureter, which extends its entire length, is at certain points exaggerated to form circular ring muscles, which in turn produce the so-called normal points of constriction, notably at the uretero-pelvic junction, the pelvic brim where the ureter crosses the iliac vessels, at the point of passage through the broad ligament, and at the intramural portion of the bladder. As the ureters are incorporated in the posterior layer of the parietal peritoneum and underlying fascia, but not attached to the muscles beneath, it follows that their upper attachments may be much more secure than those of the kidneys

* Read at the Sixth Annual Meeting, Eastern Section, American Roentgen Ray Society, Atlantic City, N. J., Jan. 22–24, 1925.

themselves, hence ptosis of the kidneys may be present without ptosis of the ureter, in which case kinks may result. Since on the right side the ureter passes beneath the end of the cecum and base of the appendix, it is well to recall what Peacock has said in regard to the differential diagnosis between ureteral colic and appendicitis, namely, that in the former the pain can be reproduced with a catheter and water, but not so in the latter condition. Inasmuch as the pelvic ureters in the female run through the broad ligaments close by the uterine cervix to enter the bladder wall, and in the male they extend close to the seminal vesicles before entering the bladder, it must follow that this close relationship to frequently diseased pelvic organs often gives rise to confusing clinical pictures resulting in many disappointing and needless operations.

FIG. 1. Sigmoid type of kidney. (Note the third pelvis overlying the fourth lumbar vertebra.)

FIG. 2. Complete reduplication of both kidneys and ureters, with four openings in bladder.

It is obviously unnecessary to state that any roentgenological examination of the ureters is futile without a coincident injection of an opaque medium. As to the technique, this varies considerably with different operators, many considering that bilateral injection may be done safely by the syringe or gravity methods, the latter being the procedure of choice with Dr. Hugh Young. We likewise have followed this procedure. Of course there are certain well-defined contraindications to simultaneous, bilateral injections, the outstanding one of which is the presence of a badly diseased kidney on one side and a vitally functioning one on the other.

The evolution of the filling solution has been from silver salts to thorium, sodium bromide, and then to a 12 per cent solution of sodium mercuric iodide, which we are now using with seemingly excellent results and but little discomfort. Following the examination in which a filling solution has been employed, an attempt should be made to withdraw the medium, especially from the large hydro- or pyonephrotic sacs. Considering the danger of absorption, no hesitancy should be shown in introducing a large catheter up to the pelvis for this purpose.

Roentgenography is the procedure regularly followed at our clinic as we feel

that roentgenoscopy is of relatively minor value. As a preliminary, a stereoscopic examination is made following the introduction of opaque catheters. This step is particularly useful in differentiating small shadows which lie apparently tangent to the catheter on the flat plate, but which when stereoscoped appear to be on an entirely different plane. Both catheters are introduced for a distance of from 20 to 30 cm., then during injection are slowly withdrawn to a distance of 5 to 10 cm. from the bladder, which brings them downward well below the pelvic brim, or better, to the uretero-vesical junction. Thus valuable evidence such as strictures, kinks, diverticula, multiple ureters, fistulous tracts and tumors may not be overlooked. Furthermore, it may be decided that shadows which lie apparently close to the ureters are really included in the filling solution.

An important point to consider at this stage is, does the filling on one or both sides elicit the identical distress which brought the patient to the urologist? In our experience, it does in a remarkably large number of cases, particularly in those characterized by obscure right-sided symptomatology.

The injected normal ureter may vary considerably in its filling and course, depending mainly on its tonicity and redundancy and the position of its kidney. The latter may be ptosed with a tortuous or so-called "kinked ureter," but the interpretation of a pathological entity rests upon narrowing of the lumen at its supposed site with dilatation above. Careful attention should be directed to the ureter below the supposed kink in order to exclude the existence of an actual underlying cause for all the changes noted above.

FIG. 3. Obstruction of ureter by grossly dilated varicose ovarian vein.

FIG. 4. Obstruction of ureter by a semi-calcified ovary—A. Calcified uterine fibroid—B.

The abnormal ureters in our series of 941 examinations in the last four years demonstrate, (1) strictures, (2) obstructing calculi, and (3) a relatively small group where the uretero-vesical valves are held open and patent—the so-called "golf hole orifice." This last condition allows regurgitation of the bladder contents and occurs in certain central nervous system disorders, such as tabes, and occasionally in chronic cystitis, particularly in the tuberculous type. The first group, strictures, resulting

in a narrowing of the lumen from either intra- or extraureteral causes, are encountered most often in the extreme upper, and in the lower or pelvic portions of the ureter. The upper lesion is usually produced by, (a) kinking of the ureter from an aberrant or anomalous renal vessel, as a rule associated with a certain degree of ptosis of the kidney. Another prolific cause of this condition is due to the fact that the fascia which binds the upper ureter to the back has failed to lengthen along with prolapse of the kidney. In our opinion, ureteral

FIG. 5. Pyonephrosis with stricture of ureter. Ruptured middle calyx with resulting retroperitoneal abscess.

kink has been a term loosely applied by roentgenologists to all degrees of angulation. It should be reserved solely for those cases which exhibit dilatation only, and that above the site of angulation. From the fact that true kinks are seldom found in the middle or lower third of the ureter, one would be led to believe that the success of the old nephropexy operation was due to the mechanical freeing of the structures in the region of the uretero-pelvic junction, rather than to the remedy of the ptosis *per se;* (b) ureteritis, and often peri-ureteritis with adhesions, these conditions being an extension of a pyelitic or pyelonephritic process; (c) calculi which act as a ball valve. It should be remembered that some of these calculi, because of their organic constituency, may be apparent only as they displace the filling solution.

The middle ureteral obstructions are most frequently due to inflammatory changes within, or to calculi. However, we have recently had a patient who showed a dilated middle ureter with a constriction just above the sacral promontory, which obstruction at operation was found to be caused by a decidedly dilated and tortuous ovarian vein, which compressed the ureter at this level.

The lower ureteral changes include the majority of ureteral calculi. Also by virtue of the close association with certain pelvic organs, the lower ureters are more subject to involvement by extension of inflammatory processes along the pelvic floor; that is to say, from the broad ligaments, tubes and ovaries in the female, the seminal vesicles in the male, and bladder, sigmoid, cecum and retrocecal appendix in both. As Rathbun has so pointedly said, any woman who presents herself with symptoms which might be referable to the urinary tract, and who gives a history of having undergone a pelvic operation, should be suspected of having ureteral stricture, and examined with that idea in mind. The distal end of the ureter, namely, the intramural portion, is often the site of a pronounced narrowing which results in a generally enlarged ureter—megaloureter—and usually, in addition, a hydronephrotic kidney. This condition, when found, points to an inflammatory change in the bladder wall, and when bilateral, it invariably has as its cause a hypertrophy of the interureteric ridge, with the rest of the bladder enlarged and trabeculated. In this hypertrophy the fibrous bands of the posterior border of the trigone tend to hold the ureteral openings together, while the rest of the bladder is drawn away. This produces a cul-de-sac known as the retrotrigonal pouch, which exists behind the ridge. The treatment of this pathology is of considerable interest, but will not be dealt with at this time except to state that surgical division of the taut ridge

FIG. 6. Bilateral megalo-ureter from obstruction by hypertrophied inter-ureteric ridge of trigone.

FIG. 7. Case similar to Figure 6 following plastic surgery on uretero-vesical valves showing ureteral regurgitation after injection of the bladder.

FIG. 8. Same as Figure 7 directly after voiding, showing spontaneous emptying of ureters.

FIG. 9. Solitary tuberculous abscess in lower pole of kidney with associated ulceration of the ureter.

relieves the tension and hence the narrowing of the ureteral orifices.

Tuberculosis of the ureter, *per se*, rarely has a pathognomonic appearance. I have in mind but one case in which the diagnosis was based largely on the ureterogram, and which was later corroborated at operation. The film showed the lower ureter ragged in outline, with an irregular course, denoting a well advanced infiltrative inflammatory change both within and about the ureter. When a kidney shows an irregular extension of its filling beyond the normal line of the tips of the calyces, or shows an abscess draining into one of the calyces, these changes, usually inconsistent with those of pyelitis or pyelonephritis, may form the basis of a conclusion that a tuberculous process is present, and if the ureter presents any distinct irregularity it is safe to assume that it is likewise involved. Some writer has said that when a branching cast-like mass in the kidney has been found, no injection is necessary on this side, but by this omission a badly diseased ureter may be missed, and if the kidney is tuberculous and removed without the ureter, a persistent sinus will probably result. Tubercle bacilli in the urine are not alone sufficient evidence upon which to base a kidney or ureteral involvement. Tuberculous mesenteric and retroperitoneal glands, particularly during the adolescent period, are not uncommon, one or more often lying sufficiently close to the ureter so that during the stage of their acute swelling they may cause obstruction by pressure. Later, when in a quiescent stage, free passage to the ureteral contents is allowed. Occasionally these glands are sufficiently calcified to be evident in the roentgenograms.

Of the many points left untouched in this brief paper, one concerns spasm of the ureter. My impression is that spasm, either of the circular or longitudinal muscle fibers, is not infrequently produced and may persist long enough to set up a hydronephrosis and hydroureter. From this may be deduced the reason why certain urologists are reporting such favorable results following mechanical dilatation.

FIG. 10. Specimens from Case IX.

In conclusion, I hope these remarks will serve to emphasize the many pathological possibilities which may cause changes in the ureter, and to stimulate their early and complete recognition. More and more the exclusion value of a negative uretero-pyelographic examination is being utilized in the diagnosis of obscure abdominal complaints. I am indebted to our urologists, Dr. Hepburn and Dr. Spillane, and to my associate, Dr. Heublein, for their cooper-

ation in the preparation of this paper and take this opportunity of expressing my gratitude to them.

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A ROENTGENOLOGICAL STUDY OF THE SKELETAL REMAINS OF THE PREHISTORIC MOUND BUILDER INDIANS OF OHIO*

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CENTURIES ago, before the first white man had set foot on American soil, the country between the Ohio and Mississippi rivers was peopled with a numerous and thriving race. For some unknown reason they disappeared completely, the Indian tribes found by the early explorers having entered the country at a later date. The first white men were impressed by large and numerous earthworks along the river valleys. Strange to say, however, the existing Indian tribes could give no information concerning them, nor did they possess any legends or traditions as to their origin.

What is now the state of Ohio is especially rich in these earthworks, there being over four thousand in this state alone. Exploration of the mounds has shown that they were of three general classes; fortification, religious and burial. Two methods of disposing of the dead were prevalent, that of cremation and burial, depending upon the tribe or culture group, and it is due to the latter custom that the skeletons are preserved.

From the evidence found in the mounds it would appear that they were a prehistoric people belonging to the stone age in development. Physically they were a vigorous, well-developed race, similar to the American Indian in type. They were a settled people having permanent habitations, a primitive agriculture and possessing the art of weaving a coarse cloth. They also had a highly developed artistic ability, although this varied with different tribes existing at the same time.

The Ohio State Archeological and Historical Society has been engaged in the exploration of these mounds for a number of years, and the material obtained is on exhibition in the museum at the Ohio State University. A collection of over five hundred skeletons was made available to the writer for study, through the courtesy of Professor W. C. Mills and Mr. H. C. Shetrone, the curators.

The remains cover all ages from infancy to old age. Some skeletons were complete and in a perfect state of preservation, although the great majority were very fragmentary. The variation in condition is probably accounted for by types of soil and drainage. Any estimate of the age of these remains is purely conjectural but as they are prehistoric, at least five hundred years must have elapsed and probably many centuries for some, as the interments had taken place at different times.

This investigation was undertaken to determine if an extinct race, apparently having had no contact with later tribes and the white race, would show the same pathological conditions as are found today. As an adjunct to external inspection of the specimens, the roentgenological method was utilized. The writer being a roentgenologist, this procedure gave information in values to which he was accustomed and promised better results than any other

* Read at the Sixth Annual Meeting, Central Section, American Roentgen Ray Society, Detroit, Mich., Feb. 19–21, 1925.

method. It had the added advantage of being rapid and also did not destroy or mutilate the material.

roentgenological method has ever been utilized anywhere. The research was begun two years ago and after close study and

PLATE 1. Bone syphilis showing different stages of development.

This is the first comprehensive examination that has ever been made of this collection and probably the first time the numerous consultations with professional colleagues, the writer believes that the proper interpretations have been made.

It was discovered at the beginning that lesions causing decalcification could not be demonstrated. Only the lime salts remained, all organic matter having been

findings might have been different. A cure that lasted from five hundred to a thousand years would convince the strongest skeptic as to the value of radiation therapy.

PLATE II. 1–2 Periosteal proliferations. 3. Coxa-vara probably from rickets. 4.Hypertrophic arthritis. 5–6. Joint infections.

absorbed thus eliminating malignancies and tuberculosis where repair had not taken place. Had these folk possessed radium or deep therapy installations the

The abnormalities found grouped themselves into three general classes; diseases of bone, fractures, and arrow and spear wounds.

BONE DISEASES

It is generally acknowledged that syphilis was unknown in Europe until 1494, and no evidence has been found in Egyptian mummies. It first appeared in Italy in that year, supposedly brought in by the soldiers of Charles VIII, some of whom had accompanied Columbus and evidently contracted the infection in Haiti.

This offered a fascinating field for investigation, as mica ornaments found in the mounds indicated a traffic extending as far south as the Carolinas, and it is reasonable to suppose that intercourse between tribes extended in a chain from the Gulf to the Great Lakes. Whether the disease existed coincidently throughout the country or was disseminated by contact from one tribe to another is of course impossible to determine.

Whatever the origin may have been, there is no doubt that lues existed among the Mound Builders of Ohio. Definite gross and roentgenological evidence of syphilis was found in three skeletons. They presented varying degrees of involvement, from a simple periosteal thickening and roughening on the crest of the tibia, to thickened ivory-like bone invading the

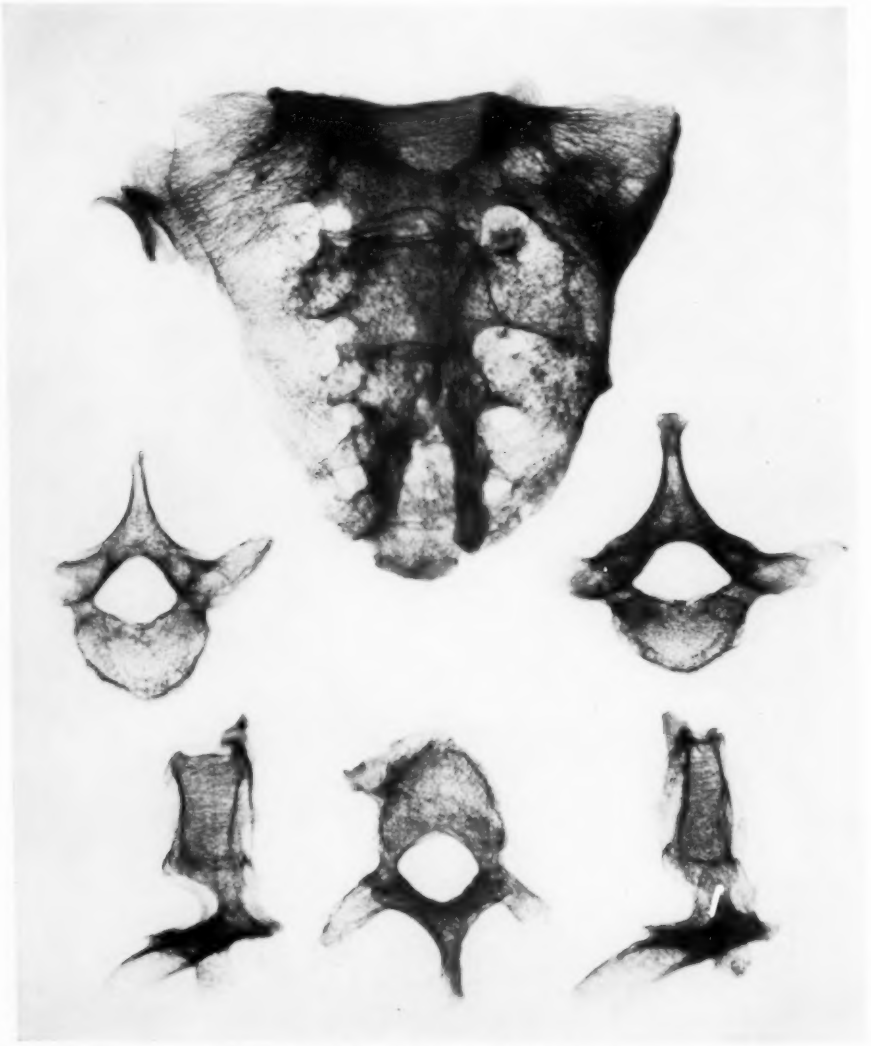

PLATE III. Hypertrophic arthritis of spine.

medullary canal with gumma formation. Two others were strongly suspicious and several more showed a possibility. Of the three positive cases, two occurred in one tribe and the third in another. The tibias were involved in all three individuals, in one case both, in another one, and in the more advanced case a tibia and ulna. Many more positive specimens would probably have been found if the skeletons had been in a less fragmentary condition.

Tuberculous bone with the characteristic softening and absorption of lime salts would have disintegrated after burial. Two specimens were found, however, that strongly resembled Pott's disease. In both there had been a flattening out of the bodies of the vertebrae, absorption of the

PLATE IV. 1–2. Probably Pott's disease dorsal spine. 3. Lower third molar in ramus of mandible.

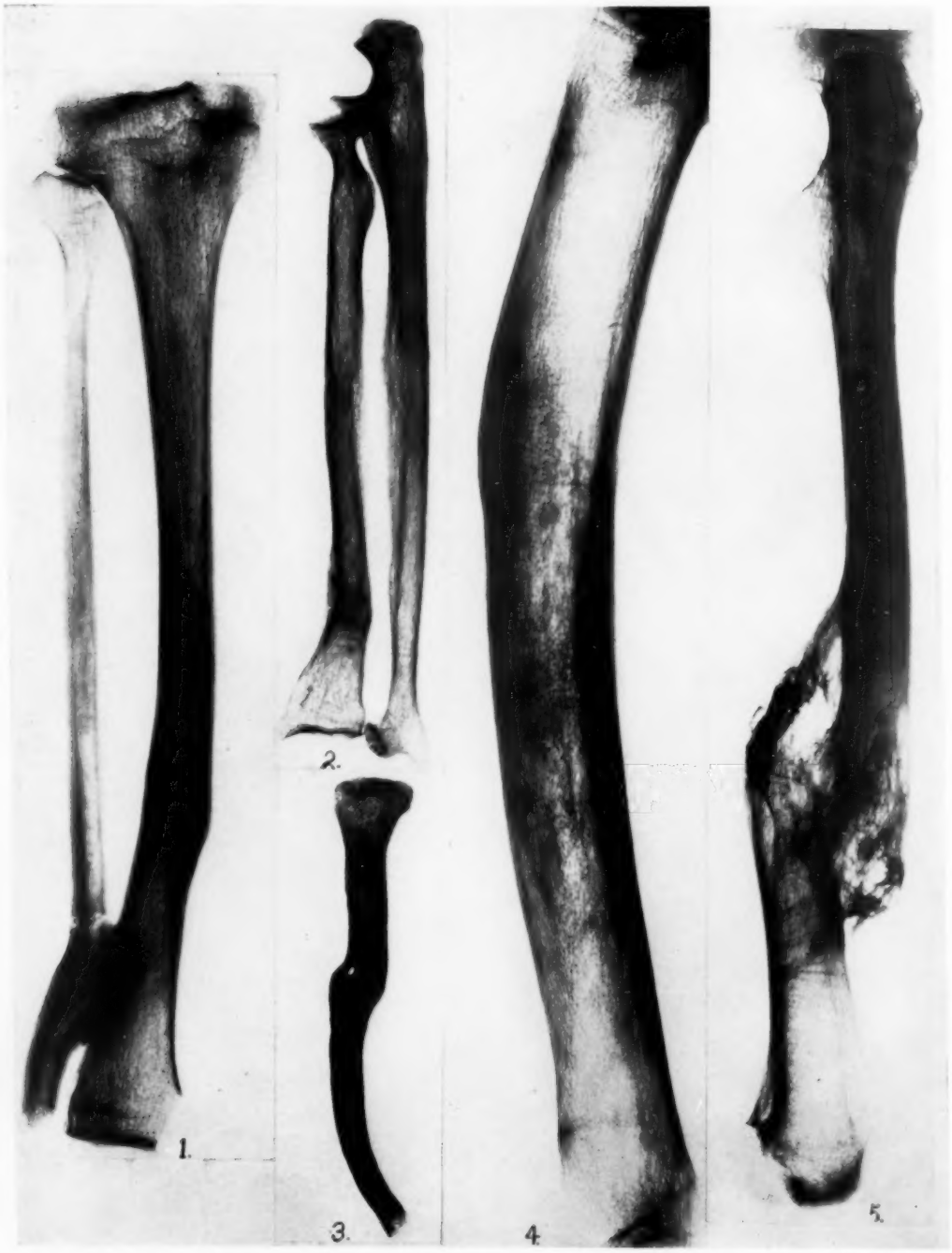

PLATE V. 1. Fracture tibia and fibula. 2. Fracture radius. 3. Fracture clavicle. 4. Osteitis deformans. 5 Fracture femur.

cartilage and complete fusion of the bodies with angulation. In one case, four dorsal vertebrae were fused together on the entire anterior and lateral aspects with the second and third flattened out to thin disks. The new bone formation was very slight. In the other specimen, three dorsal vertebrae were involved and fused into a bony mass. This skeleton was that of a little old woman, as shown by the edentulous mandible found with it. The deformity was evidently not a sufficient handicap to prevent her from living many years.

There was a coxa vara with partial absorption of the neck of the femur more marked on the upper aspect. The base of the neck was smaller than normal, making the great trochanter very prominent. The angle of the neck was normal and the head rotated upward. There was a compensatory bowing in the shaft to allow for the postural change. The arrangement of the striae of the head and neck gave no indication of injury. There was also a slight roughening around the periphery of the articular surface of the head. This deformity was probably due to rickets, although the possibility of an infectious process should not be overlooked.

A number of bones were found, most of them in a fragmentary condition, presenting similar characteristic lesions, among which were two pairs of tibias. These bones were unusually long, and markedly bowed. They were uniformly enlarged in diameter and slightly irregular in outline. There was no well-defined medullary canal, this space being occupied by a rarefied network of bone. The cortex was thinner than normal, presenting some sclerosis in irregularly placed portions. One pair was accompanied by an ulna showing the same changes. The characteristics shown are typical of osteitis deformans. Unfortunately the skulls were in a very fragmentary condition so that cranial pathology could not be demonstrated.

As might be expected in a primitive people, improperly clothed and housed and without dentists to extract the teeth and laryngologists to remove the tonsils, arthritis was very common. Many specimens of hypertrophic arthritis were observed, the favorite location being in the spinal column. The lesions do not differ in any respect from those found at the present time. The spinal adjustment cult came into existence one thousand years too late, for here was a fertile field for their manipulations.

Bone infections were very few. It seems reasonable to suppose that the majority would die and the bones disintegrate after burial. The only joint discovered was of the elbow with complete destruction of the articular surfaces of the humerus, radius and ulna. There was a complete fusing of all the bones but without bone proliferation. The shafts of the bone showed no involvement. It is impossible to determine the exact cause, which may have been an acute pyogenic infection or tuberculosis.

A humerus was found, the lower two-thirds of which strongly resembled a healed osteomyelitis. It was thought at first that this might be an osteitis deformans, but the cortex and medulla in the upper third were normal.

There were several periosteal proliferations among which was a femur with an extensive irregular outgrowth of dense bone in the outer posterior aspect of the shaft. The individual possessing this femur was probably caught from behind and punctured with a spear. As his opponent had doubtless neglected to sterilize his spear head, which previously may have been plunged into the vitals of a bear or deer, it is within the bounds of probability that infection may have been carried into the wound.

FRACTURES

Of fractures, which must have been common, the author found six, including the clavicle, radius, femur, tibia and fibula, and skull. There must have been some crude attempt at reduction or at least immobilization as, while the apposition was not good, the general alinement of the bones was very fair, and doubtless gave useful function. The results would compare very favorably with those obtained before the use of the roentgen ray. The poorest result was that of a fracture of the lower third of the tibia and fibula. Considering, however, the difficulty

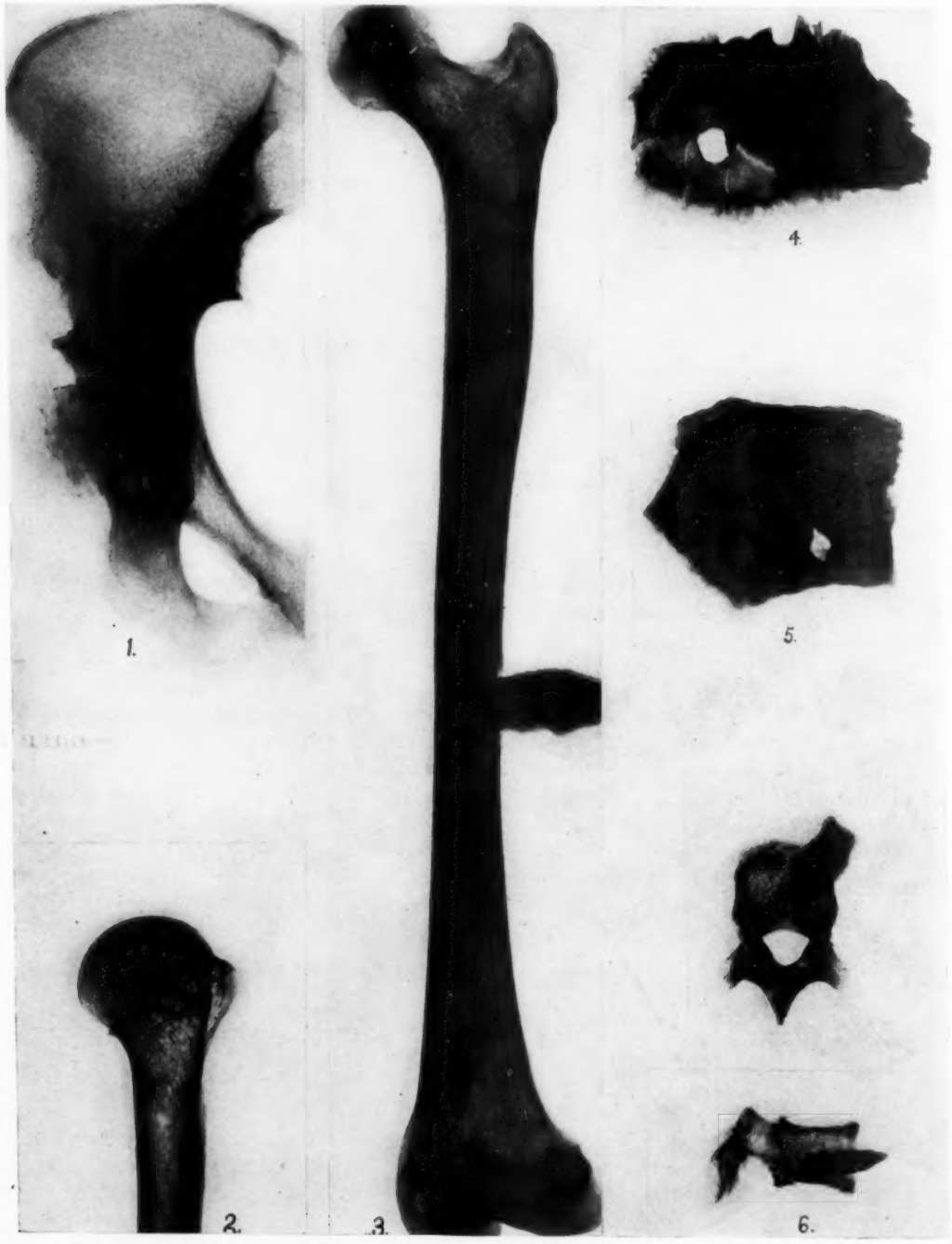

PLATE VI. 1. Spear head in acetabulum. 2. Arrow point in neck of humerus. 3. Spear head in shaft of femur. 4. Opening in temporal bone possibly from trephining. 5. Arrow wound of parietal bone. 6. Arrow point in body of dorsal vertebra.

surgeons have today in treating the same type of fracture with the roentgen ray and every modern appliance at their command, the Indian medicine man did very well.

An investigation of the teeth would be very profitable as many abscesses were noted, but this was reserved for future study. It is interesting to note, however, that in many cases the entire occlusal surface had disappeared, being ground down by the grit and dirt in the coarse food consumed. One unusual anomaly was found. There was a fully developed lower third molar situated in the ramus of the mandible just below the condyle. It was lying transversely with the crown directed outward and clearly visible through a round opening slightly larger than the tooth. The roots were curved and covered with a thin convex shell of bone. The opposite third molar was partially impacted.

ARROW AND SPEAR WOUNDS

While perhaps lacking in scientific interest the specimens showing arrow and spear wounds were extremely interesting. In the skull, one was found in a parietal bone. The depression through the outer table was diamond-shaped corresponding to an arrow point. The inner table showed comminution and had been pushed inward. The edges of the opening and fractured portions were covered with new bone, showing that the individual lived for some time. Another parietal bone had a similar wound with complete penetration and inward displacement of the inner table. There was evidence that the wound had been infected as the outer table had disappeared and irregular masses of new bone appeared around the edges. This was smooth and rounded showing that some time had elapsed since the injury.

A humerus showed an arrow point buried in the neck for 2 cm. just below the head with the flint broken off flush with the bone. There was no softening or repair around it, showing that death occurred promptly. From the location, the wound was incurred with the arm elevated and the brachial artery was severed.

A femur showed a spear point in the middle of the shaft penetrating through the cortex into the medullary cavity. The wound of entrance was much larger than the flint and showed evidence of softening and absorption. From the amount of bone destruction around the spear head, the warrior must have carried it for weeks or months, suffering exquisite torture until death ensued from osteomyelitis, evidence of which appeared in the medullary canal.

When another skeleton was disinterred, a large triangular piece of flint was found in the cavity of the acetabulum. The thrust was of sufficient strength to force the spear head between the head of the femur and the acetabulum, where the point broke off. Even if the Indian survived the wound, which is doubtful, his activities were considerably reduced in the future.

The last specimen was a wound of the spine. A small sharp arrow point 1¼ inches long was firmly imbedded two-thirds of its length in the body of a dorsal vertebra and showed no evidence of softening of the bone. The vertebra was the sixth, and the arrow entered obliquely from the front on the left side. From the location it must have passed through the aorta causing almost immediate death from hemorrhage.

CONCLUSIONS

This is the first roentgenological study that has been made of the skeletal remains of the Mound Builder Indians of Ohio.

From the material at hand the same pathological conditions were demonstrated that exist today.

It has been clearly proven that syphilis existed and was a fairly common disease.

ORAL ADMINISTRATION OF SODIUM TETRABROMPHENOLPHTHALEIN—PRELIMINARY REPORT*

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SODIUM tetrabromphenolphthalein offers great possibilities in the diagnosis of gall-bladder disease, but its intravenous use is handicapped by occasional severe reactions and the possibility of necrosis at the site of injection.

Oral administration would be a more direct method. The dye would be absorbed by the portal circulation, and carried immediately to the liver, where it is excreted, and the systemic circulation would be protected from any great concentration of the dye.

In attempting oral administration, the sodium salt was used because its free solubility would favor absorption. Bicarbonate of soda was given with it to prevent precipitation by the hydrochloric acid of the stomach. It was found to be irritating to the stomach, with an unpleasant and lasting taste, so that if given in solution or on an empty stomach, it is usually promptly vomited. Placing it in capsules, and giving these at intervals during and after a full meal, seems to minimize the irritating effect. As the evening meal is usually the heaviest, the dye has been given at this time. The dose has been approximately 0.1 gm. per kilogram of body weight, up to 70 kilograms, above which the dose has been reduced slightly. This is divided into capsules, to give from 0.5 to 1 gm. to the capsule. Two of these are given at the beginning of the meal, two about the middle, and two at the end. If more are needed to complete the dose, they are given at intervals of a quarter to a half hour afterwards. This distributes the dye in the stomach contents, and prevents all of the dye from being liberated at one time or in one portion of the stomach. The soda may be placed in the capsules or given separately. Nothing is given by mouth the following morning until after films have been obtained. Then a general diet is given.

Films are taken the following morning, about noon, and late in the afternoon, at approximately 12 to 14 hours, 18 hours, and 24 hours. Films on the second morning, usually do not show a gall-bladder outline, and when present it is probably a pathological finding. The greatest size is usually reached on the 12- to 14-hour film, while the 18- and 24-hour films show a much smaller and denser shadow. Following food there is usually a distinct decrease in the size of the shadow. For this reason, general diet is given following the first films, as it serves to determine the distensibility of the gall-bladder. Similarly, the full meal given with the dye probably causes the normal gall-bladder to empty, at least partially, and give room for opaque bile.

This routine has the disadvantage of disregarding the time of appearance of the dye in the gall-bladder, but as the cycle of filling and emptying is completed in slightly more than twenty-four hours, some portion of it must be neglected, or the patient disturbed repeatedly during the night.

The dye has been administered by this method 37 times to 32 individuals, excluding 10 administrations where the dosage was insufficient or there was wide variation from the routine. All of these have shown gall-bladder outlines, except four. Of these 2 were clinically cases of cholecystitis, and 3 vomited the dye shortly after it was given. The gall-bladder has been visualized in all normal cases, who retained it for more than an hour.

There have been no severe reactions following oral administration. All but 12 have had some sensation of nausea or discomfort in the stomach, this usually beginning about an hour after giving the dye, and lasting from half an hour to an hour. A few have been nauseated for two or three hours. Vomiting has occurred 10 times, but none of these could be persuaded to eat a full meal. It has never been severe and has stopped as

* Read at the Sixth Annual Meeting, Central Section, AMERICAN ROENTGEN RAY SOCIETY, Detroit, Mich., Feb. 19–21, 1925.

soon as the stomach was emptied. Gall-bladder shadows were obtained in all of these except 3, and one of these probably had a cholecystitis. Seven have had a slight looseness of the bowels on the following day. Stools were formed except in one case. Slight headache was complained of 5 times and 4 had slight vertigo. There was no backache nor incontinence.

Objectively, little of importance was found. Flushing of the face was noted 3 times and perspiration 3 times. Pulse, temperature and respiration showed no significant changes. Blood pressure showed no marked change, the greatest rise was 30 mm. systolic, and the greatest fall 20 mm. systolic.

Urine has been consistently negative. Several attempts to recover the dye from the urine have failed. The dye is present in the feces as tetrabromphenolphthalein, the acid reaction having separated the sodium. Attempts to show the dye in the blood have failed, though control experiments show traces of the dye.

Recently the dye has been given in gelatin capsules, hardened by exposure to formaldehyde. This carries the dye through the stomach without the capsules dissolving, and protects the dye more completely from the hydrochloric acid of the stomach. Thus, all of the dye reaches the small intestine, as the soluble sodium salt and none is precipitated as the insoluble acid. That a considerable fraction of the dose may be rendered insoluble by the gastric juice is shown by the dense shadows of the dye in the colon. As the whole dose is available for absorption, so much of the dye need not be given, and the dose has been decreased to 75 mg. per kilogram, with possibility of further reduction. This smaller dose is naturally less irritating and symptoms have been milder or absent.

Acknowledgment is due to Drs. L. A Brunsting, J. D. Miller, and W. J. Jonker for clinical observations and for taking the dye early in the work.

SUMMARY

1. Sodium tetrabromphenolphthalein is absorbed when administered by mouth, and can be safely given in amounts sufficient to outline the gall-bladder.

2. The oral method has the following advantages:

(*a*) It gives the patient less discomfort.

(*b*) There is no danger of sloughing.

(*c*) It is less time consuming.

(*d*) It is safer, as the dye does not reach as great a concentration in the systemic circulation, if it reaches the systemic circulation at all.

3. The chief disadvantage of the oral method is that a certain number of patients will not be able to retain the dye. Another disadvantage is that a complete record of the filling and emptying of the gall-bladder is not obtained.

4. Diagnosis will probably depend on the same factors as with the intravenous method.

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

Editor: ARTHUR C. CHRISTIE, M.D.

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Information of interest to all readers will be found on page iii. Lists of officers of The American Roentgen Ray Society and The American Radium Society will be found below.

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Publishers: PAUL B. HOEBER, Inc., 67-69 E. 59th St., N. Y. C.

Twenty-sixth Annual Meeting: At Washington, D. C. September 22-25, 1925.

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Seventh Annual Meeting: To be announced.

CENTRAL SECTION: RAYMOND C. BEELER, Chairman, Indianapolis, Ind., LAWRENCE REYNOLDS, Vice-Chairman, Detroit, Mich., E. R. BADER, Secretary, Cincinnati, O.

Seventh Annual Meeting: At Chicago, Illinois.

WESTERN SECTION: H. B. THOMPSON, Chairman, Seattle, Wash., IRVING INGBER, Secretary, San Francisco.

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Standardization Committee: WM. DUANE, Chairman, Boston, HENRY SCHMITZ, Chicago, A. WEATHERWAX, Philadelphia.

Tenth Annual Meeting: At Atlantic City, N. J., May 25-26, 1925.

EDITORIALS

THE LIMITS OF SAFETY IN ADMINISTRATION OF TETRABROMPHENOLPHTHALEIN

THE use of tetrabromphenolphthalein for visualization of the gall-bladder has now become very general, and reports from many different clinicians indicate its decided value in the diagnosis of gall-bladder disease. The principal objections to the use of the method are the toxicity of the drug and the fact that it must be administered intravenously.

The toxic symptoms are thus described by Carman.[1]

"The typical severe reaction is one of vasomotor shock. It begins usually within five to ten minutes. There is first a sense of uneasiness, followed by severe pain in the region of the dorsal and lumbar spine, flushing of the skin, and a rise of from 10 to 50 mm. in blood pressure, followed within three to five minutes by a sharp fall. In one instance the systolic pressure fell to 70. Gradually, during the next fifteen to thirty minutes, the pressure returns to its previous normal level. With the fall in blood pressure, the patient may have intestinal cramps, become nauseated and vomit. The skin becomes cold. Patients may perspire freely, or have incontinence of the bowel and bladder. As several such reactions occurred under our observation we concluded that the method was unsuitable for patients with any type of cardiovascular disease, particularly arteriosclerosis and chronic cardiac disease. Patients with extreme neurotic tendencies, and those who are apprehensive, will invariably experience a degree of reaction which is annoying, although not alarming.

"Because of the numerous reactions the standard dose of 5.5 gm. was reduced to 4.5 gm. The results were much more satisfactory, but not without a few disappointments. Some of the patients became flushed, had slight pain in the back, and transient nausea for from five to ten minutes. Occasionally a delayed reaction developed four or five hours after injection. These symptoms seemed to be brought on by the patient's getting out of bed and walking about the room, or changing suddenly from a recumbent to an upright position. In the delayed reactions the nausea and vomiting gradually subsided in from one to three hours."

Experience indicates that minute care in the administration of the drug and in the care of the patient will greatly reduce the number of reactions and lessen the severity in those who do have reactions. The apparatus must be prepared with scrupulous attention to cleanliness and asepsis. The operator must absolutely assure himself that the needle is in the vein and that there is no leakage of the solution into surrounding tissues. The injection must be given slowly—a period of at least ten minutes being consumed in injecting the entire amount. No food should be taken on the morning of the injection and a light non-protein diet should be given during the succeeding twenty-four hours. The amount administered should not exceed 5 gm., and this amount is necessary only in heavy patients.

Reports from various sources now indicate that careful technique and avoidance of too large dosage reduces the disagreeable reactions to a point where they form no serious contraindication to the use of this method.

Recently clinicians have been reporting the use of tetraiodophenolphthalein[1] as a substitute for the tetrabrom salt. It seems to have the advantage of producing a denser shadow than an equal amount of the tetrabrom salt and may therefore be given in smaller doses with consequent reduction in the toxic effects.

It is hoped that continued investigation will finally produce a salt that is free from disagreeable toxic manifestations.

Another limitation of the method is the fact that it necessitates intravenous injection. Numerous attempts have been made to secure a gall-bladder shadow by giving the drug orally and also by means of rectal injections. In this number of the Journal (page 368) Menees and Robinson report some success by administering the tetrabromphenolphthalein in capsules treated with formaldehyde to render them insoluble in the stomach. We also publish on page 378 of this issue a letter from Dr. Wm. H. Stewart stating that he has secured

[1] CARMAN, RUSSELL D., and COUNSELLER, VIRGIL S. Roentgenologic diagnosis of cholecystic disease with the aid of the sodium salt of tetrabromphenolphthalein. AM. J. ROENTGENOL. & RAD. THERAP., November, 1924, xii, 403–413.

[1] WHITAKER, LESTER R., and MILLIKEN, GIBBS. A comparison of sodium tetrabromphenolphthalein with sodium tetraiodophenolphthalein in gall-bladder radiography. *Surg., Gynec. & Obst.*, January, 1925, xl, 17–23. (Abs. AM. J. ROENTGENOL. & RAD. THERAP., February, 1925, xiii, 298.)

satisfactory results by administration of the tetraiodophenolphthalein into the jejunum through a duodenal tube. A great advance would be made if a salt could be obtained which would be non-irritating to the gastric and intestinal mucosa.

In spite of the toxic properties of the drug no fatal results due to its administration have been reported, but there is no doubt that much harm and even fatalities might be caused by over-dosage. As a warning against too large dosage we call attention to experimental work described in the article below which is republished by permission from the Journal of the American Medical Association.[1]

"The tetrahalogenphenolphthaleins bid fair to become important substances in medicine. The chlorin compound has been introduced in a liver function test, the bromin compound is used in visualizing the gallbladder for roentgen-ray diagnosis, and the iodin compound has been in use for some years as a local antiseptic.

"All the earlier workers found these substances to be practically nontoxic. Only Graham and Cole, in their recent studies on roentgen-ray visualization of the gallbladder, obtained any toxic effects with large doses administered intravenously. We have seen no accounts of lesions produced by these compounds.

"We here report briefly on experiments undertaken primarily to determine the upper safe limits of dosage. A detailed description of the findings will be published later. Fifteen rabbits and seven dogs were used. Five per cent solutions were injected intravenously at a slow rate.

"The results with tetrachlorphenolphthalein and tetrabromphenolphthalein were practically identical. With dogs and rabbits, except for variations due probably to differences in susceptibility, they were in general as follows:

"Doses of about 0.1 gm. per kilogram of body weight produced no symptoms or lesions except in one rabbit, and the substances injected were not present in the urine.

"Doses of about 0.2 gm. per kilogram produced some weakness, and the substances were usually present in the urine. Lesions in the liver were minimal or absent.

"Doses of from 0.3 to 0.4 gm. per kilogram made the animals very sick at once. They showed great weakness, even paralysis of the hind legs, staggering, vomiting (in dogs only) and repeated bowel evacuations, and died in from five to eight hours. One rabbit died immediately. Their urine showed large amounts of the injected substances, albumin, casts and in some instances hemoglobin. Necropsies showed remarkably extensive degeneration amounting almost to necrosis of the liver lobules, and general disruption of the liver architecture, with intense congestion and hemorrhage in many necrotic areas. There were lesions of the kidneys and spleen. In the case of the more deeply colored chlor compound, the injected substance was demonstrated in all the tissues of the body. (The characteristic purple was brought out by application of ammonia.)

"Doses of from 0.4 to 0.5 gm. per kilogram killed the rabbits at once or within fifteen minutes, with acute convulsive symptoms. (No dogs received these doses.) The animals died from respiratory failure, the heart continuing to beat for several minutes. At necropsy, performed immediately, their livers showed profound congestion and microscopically acute degeneration of the liver cells except in one instance. Unlike the animals that survived from five to eight hours, these showed preservation of the general liver architecture. Extensive degeneration of the liver produced in fifteen minutes is remarkable.

"A peculiar feature was the lack of gradation between toxic and nontoxic doses. Either the animals showed almost no lesions or the lesions were extreme.

"It will be noted that the doses needed to produce severe symptoms and liver lesions were enormously larger than those used in the tetrachlorphenolphthalein test for liver function (0.005 gm. per kilogram). While the amount of tetrabromphenolphthalein used for gallbladder visualization (0.1 gm. per kilogram) is also safely below the toxic dose, the margin is not so large, and suggests the necessity of caution in cases in which the liver parenchyma is already damaged by disease."

[1] Ottenberg, Reuben, and Abramson, Harold A. Production of liver necrosis by tetrachlorphenolphthalein and tetrabromphenolphthalein. *J. Am. M. Ass.*, March 14, 1925, lxxxiv, 800. (Republished by permission.)

THE REGISTRY OF BONE SARCOMA

The following remarks of Dr. E. A. Codman, made at the meeting of the Central Section of the American Roentgen Ray Society at Detroit, February 19 to 21, 1925, are published in order again to call the attention of roentgenologists to the important work being done by the Registry of Bone Sarcoma:

I have a paper here which I have carefully prepared and which is already in print to appear in the February number of the American Journal of Roentgenology and Radium Therapy. The paper deals with the nomenclature used by the Registry, but it seemed to me that as long as this paper is about to be published it would be better to take the time allowed me to tell you about the Registry rather than about tumors and the classification of tumors.

The Registry of Bone Sarcoma was founded about four years ago and has been carried on as an activity of the American College of Surgeons. Now the American College of Surgeons really has no more to do with it than you have, except that they pay its expenses. They allow me about $2,000.00 a year for clerical help, and the actual expenses of the Registry, but the collection is just as much at the service of roentgenologists as of the members of the American College of

Surgeons. Its whole aim is primarily cooperative; it is at the service of any student of bone tumors.

It is clear that the pathologists of the country have used different terms in speaking of these sarcomas, for they have published nomenclatures in their different books. Roentgenologists have sometimes also made up classifications. The clinical surgeons are usually like the surgeon to whom Dr. Warthin referred who did not want to know the different divisions, asking from the pathologist only whether a tumor is a sarcoma or not. Even then, we find that in some cases there is a disagreement among pathologists as to whether a tumor is actually benign or malignant. In regard to giant cell sarcoma this distinction is practicularly important. The word "sarcoma" should only be used when we believe a tumor is malignant. That was the reason that Bloodgood devised the name giant celled "tumor" rather than "sarcoma" because he used the word tumor educationally in the sense of a swelling, not necessarily a new growth. It has not been determined as yet whether giant cell tumors are essentially neoplasms or the results of atypical inflammation and repair. At any rate they seldom if ever metastasize.

Notwithstanding Dr. Warthin's statement that in the early days he had cases where he was satisfied that metastases from these giant cell tumors were proved, the Registry has been unable to collect any clear instances where these tumors have metastasized. Mistakes in the diagnosis of these tumors undoubtedly have been made and unfortunately the orginal slides and roentgenograms have been lost. We note that pathologists all over the country differ considerably on the actual diagnosis of bone tumors, and we cannot accept the statements of any body of men, or any committee, or anybody else unless we have microscopic evidence which can be passed around to all those who are interested in order that they may each have their chance to judge. This is the basic idea of the Registry.

I am registrar of this Registry, but I am neither pathologist, roentgenologist nor hardly a surgeon. I am a collector of cases and collect from surgeons, hospitals, or wherever I can get them. The whole history of each case, with the microscopic slides, the roentgen prints, etc., are put in an envelope. What you will see in the other room are these envelopes, each containing the complete clinical report of a case, with slides, history, roentgenogram and late result. Boxes of these envelopes are sent about by the Registry to the different laboratories which are willing to take the time to look over them and study them. I want here to thank Dr. Warthin, who has not only given us his opinion about cases from other places but has sent interesting cases of his own. We should have similar cooperation from all laboratories until this question is sufficiently settled so that we can speak the same language at least, and call these tumors by names which will mean the same clinical entity to the roentgenologist, the pathologist and the surgeon. There are some twenty or thirty laboratories at the present time cooperating by studying this collection of tumors in rotation. Each laboratory is studying the cases, showing them to their students and their clinical staffs, and the most prominent pathologists of each clinic write their opinion of the cases, and the name which they prefer for each individual case.

The cases which you see in the other room have been arranged more or less according to what the pathologists who sent them have told me. Sometimes there is so much difference of opinion that I have to classify them, but it is always with the reservation that those examining the cases may look inside the envelope to see the opinions of the various pathologists.

I wish mainly to demonstrate at the exhibition two forms of tumors which form the bulk of all bone tumors. They are the osteogenic sarcoma (so far as I know there is no difference between the terms osteogenic which we use, and osteogenetic, which Dr. Warthin uses) and the benign giant cell tumors.

We have a collection of over a hundred giant cell tumors but have no clear cases of metastases from these. In the exhibition in the other room you will find that an especial effort has been made to contrast

the roentgenological appearance of these two classes of tumors. Since nearly all the osteogenic sarcomas do metastasize to the lungs and the patients die within a few years, the importance of distinguishing between these two classes is obvious. All osteogenic sarcomas have practically the same life history whether fibro, chondro, myxo or osteo. Some are slightly slower growing than others, but nearly all eventually metastasize to the lungs and the patients die in spite of treatment, surgical or roentgenologic. On the other hand, the cases of giant cell tumor live in spite of treatment unless they die from surgical sepsis.

Even in the few cases of osteogenic sarcoma which have lived over five years after amputation there is some little doubt about the accuracy of the diagnosis.

Since the results of surgery in bone sarcoma have been so poor an attempt to treat them by radiotherapy is certainly justifiable. If it makes the patients more comfortable to treat these cases by roentgen therapy, even though they are going to have metastases it seems reasonable to do it. If these experiments are made they should be registered, because in the course of time we shall collect enough cases so that we can compare the results of roentgen therapy with those of surgery, and therefore it is very necessary to register all cases.

Dr. Ewing and Dr. Bloodgood are the other members of this committee. They have examined or are examining all the registered cases and have registered most of their own. Even with this expert help, in five years we have only collected something over 600. So every case we get counts.

In order to get the nomenclature down to a point where we can use it for our specimens, we have published a little sheet, of which there are copies in the other room sufficient for each person. We hope this will be framed and posted in all roentgenologic and pathologic laboratories which have no other classification.

EDITOR'S NOTE: Dr. Codman then showed a series of lantern slides which were made from the same cases illustrated in this paper which appeared in the February number of the American Journal of Roentgenology and Radium Therapy.

At the close of the discussion he made an appeal to the members of the Society to register all the cases of supposed bone sarcoma which they treat, even if no microscopic section can be obtained. To register a case one need send only a brief history and one or two characteristic roentgenograms. Much detail is to be avoided. The Registrar will write once a year asking for a note on the progress of the case. Address Dr. E. A. Codman, Registrar, 227 Beacon St., Boston, Mass.

Dr Codman's paper on this subject, which was published in the February number of this Journal, is now available in monograph form and can be obtained from the publisher of this Journal.

Subscribers to THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY *visiting New York City, are invited to make the office of* THE JOURNAL (*69 East 59th Street, New York*) *their headquarters. Mail, packages or bundles may be addressed in our care. Hotel reservations will gladly be made for those advising us in advance; kindly notify us in detail as to requirements and prices. List of operations in New York hospitals on file in our office daily.*

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this column solicited promptly after the events to which they refer.

RADIOLOGY AMERICAN MEDICAL ASSOCIATION

Radiology has been given three sessions in the Section on Miscellaneous Topics at the meeting of the American Medical Association, whic his to be held at Atlantic City, May 25–29, inclusive.

The sessions on Radiology will be held on the Pier, on the afternoons of May 27, 28, and 29.

This is an opportunity for Radiology to intrench itself permanently in the activities of the Association.

A large attendance is desirable, and when you register be sure to write in the word "Radiology."

The following is the program:

Presidential Address
P. M. HICKEY, M.D., University of Michigan, Ann Arbor, Michigan
Title to be announced later
A. E. BARCLAY, M.D., Manchester, England
Symposium on Peptic Ulcer:
Pre-operative Radiological Findings
RUSSELL D. CARMAN, M.D., Rochester, Minnesota
Post-operative Radiological Findings
JAMES T. CASE, M.D., Battle Creek, Michigan
Pathology
HOWARD T. KARSNER, M.D., Western Reserve University, Cleveland Ohio
Surgical Treatment
HUGH CABOT, M.D., University of Michigan, Ann Arbor, Michigan
Medical Treatment
LEWELLYS F. BARKER, M.D., Baltimore, Maryland
Some Clinical Symptoms Indicating a Pyelographic Study of the Upper Genito-urinary Tract
BERNARD H. NICHOLS, M.D., Cleveland, Ohio
A Radiological Retrospect
ALBERT SOILAND, M.D., Los Angeles, California
X-ray Treatment in Bronchial Asthma and Chronic Bronchitis
I. GERBER, M.D., Providence, Rhode Island
The Results of Radium Therapy for Recurrent Carcinoma of the Breast
BURTON J. LEE, M.D., and NORMAN E. TANNENBAUM, M.D., New York City
Title to be announced later
F. W. HARTMAN, M.D., A. BOLLIGER, M.D., and HOWARD P. DOUB, M.D., Henry Ford Hospital Detroit, Michigan
Clinical and Roentgenological Consideration of Thymus Enlargement, and the Treatment of its Hyperfunction
LAWRENCE R. DE BUYS, M.D., and ERNEST CHARLES SAMUEL, M.D., New Orleans, Louisiana
Differential Diagnosis of Mediastinal Tumors
WILLIAM A. EVANS, M.D., Detroit, Michigan
The Roentgen Ray in the Treatment of Local Inflammations, Cellulitis, and Carbuncles
FRED M. HODGES, M.D., Richmond Virginia
The Control of Non-malignant Uterine Hemorrhage by Radiation
W. S. NEWCOMET, M.D., Philadelphia, Pennsylvania
Roentgen Diagnosis and Treatment of Thyoma
THOMAS A. GROOVER, M.D., A. C. CHRISTIE, M.D., E. A. MERRITT, M.D., and F. O. COE, M.D., Washington, D. C.
The *X*-ray Examination of Sinuses and Mastoids in Children
E. H. SKINNER, M.D., Kansas City, Missouri
The Sella Turcica and the Significance of Changes in its Radiographic Appearance
JOHN D. CAMP, M.D., Boston, Massachusetts
Further Observations on Antiperistalsis in the Duodenum
W. F. HENDERSON, M.D., Jackson, Miss.

CANADIAN RADIOLOGICAL SOCIETY ANNUAL MEETING

The Canadian Radiological Society will meet in conjunction with the Canadian Medical Association at Regina, Saskatchewan, June 22 [to 26, 1925. Papers have been promised by the following members and guests but the subjects are not yet available: Dr. Pritchard, Battle Creek, Mich.; Dr. Richards, Toronto, Ont.; Dr. Pacini, Chicago, Ill.; Dr. Pirie, Montreal, Que.; Dr. H. H. Cheney, Montreal, Que.; Drs. Stewart and Pritchard, Ninette, Man.; Dr. Mooney, Edmonton, Alberta; Dr. McGuffin, Calgary, Alberta; Dr. Gorell, Minnedosa, Manitoba; Dr. Frank Smith, Winnipeg, Manitoba; Dr. Ferrier, Winnipeg, Manitoba.

A cordial invitation is extended to all members of the American Roentgen Ray Society.

E. C. BROOKS.
Secretary-Treasurer.

SIXTH ITALIAN CONGRESS ON MEDICAL RADIOLOGY, TRIESTE, ITALY

The Sixth Italian Congress on Medical Radiology will be held at Trieste, May 7 to 10, 1925. Subjects assigned at the

meeting of the Societa Italiana Radiologia Medica at the last Congress at Palermo are the following:

1. Radiology of the Bile Ducts, Professor Pasquale Tandoia, Napoli.
2. Radiology of Affections of the Pleura, Professor Giacoma Pesci, Genova.
3. Radiotherapy of the Endocrine Glands, Professor Eugenio Milani, Roma.

Communications will follow and among those which will have precedence are the ones having some connection or relationship with the allied subjects.

In addition to the usual display of radiological apparatus an exhibit, free to all members, will be held in connection with the Congress for the purpose of illustrating more clearly progress in technique and diagnosis derived from Italian radiology of recent years.

The formal opening of the Congress will take place upon the morning of May 7 and will be followed by presentation of reports and communications. The meeting of members of the Societa Italiana Radiologia Medica has been set for the morning of May 8. The Congress will close on the evening of May 9. The following day (Sunday, May 10) has been reserved for an excursion to the grottoes of Postumia.

All members of the Societa Italiana Radiologia Medica who have paid their dues for the year 1925 are eligible for participation in the Congress. Non-members who desire to take part in the proceedings of the Congress may do so by remitting the sum of 20 lire, the price of membership in the Congress.

Families of members may avail themselves of the reduction in railroad fare by registering and remitting the sum of 10 lire.

Further information may be obtained from the Secretary-General of the Congress.

Applications for membership and titles of papers, together with brief abstracts, should be forwarded not later than March 31 to the President of the Sixth Italian Congress on Radiology: Dr. Massimiliano Gortan, Ospedale civico Regina Elena, Trieste.

MEETINGS OF ROENTGEN SOCIETIES

We contemplate the publication of a list of roentgen society meetings such as that below, in each issue of the Journal, gradually adding other home and foreign societies as the information reaches us. Secretaries of societies not here listed are requested to send the necessary information to the editor.

NEW YORK ROENTGEN SOCIETY
Secretary, Dr. Eugene V. Powell, 217 East 42d St.
Meets monthly on second Monday, New York Academy of Medicine.

THE CANADIAN RADIOLOGICAL SOCIETY
Secretary, Dr. E. C. Brooks, Montreal.
Annual meeting, Regina, Sask., June 15–19, 1925.

ROENTGEN RAY SOCIETY OF CENTRAL PENNSYLVANIA
Secretary, Dr. W. E. Reiley, Clearfield, Penna.
Two meetings a year, April and October.
Coming meeting at William Penn Hotel, Pittsburgh, Penna., April 25, 1925.

THE NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. Frank E. Wheatley, 520 Beacon St., Boston, Mass.
Meets monthly on third Friday, Boston Medical Library.

PHILADELPHIA ROENTGEN RAY SOCIETY
Secretary, Dr. Eugene Pendergrass, Univeristy of Pennsylvania, Philadelphia.
Meets monthly on first Thursday evening, Pennsylvania Hospital

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. Edward S. Blaine, 2005 S. Wabash Ave.
Meets monthly on second Friday from October to May (except during month of December) at Virginia Hotel. Dinner at 6 P.M., scientific session at 8 P.M.

PACIFIC COAST ROENTGEN RAY SOCIETY
Secretary, Dr. R. G. Van Nuys, San Francisco.
Two meetings a year.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. E. P. McNamee.
Meetings are held at 6 o'clock at the University Club, on the fourth Monday evening of each month from September to April, inclusive.

CENTRAL ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. C. J. McCullough, Decatur, Illinois.
Regular meetings held quarterly.

SOCIETA ITALIANA RADIOLOGIA MEDICA
Secretary, Professor M. Ponzio, University of Torino, Torino.
Sixth Congress of this Society will take place at Trieste, May 7–10, 1925, under the presidency of Professor Gortan.

THE BRITISH RÖNTGEN SOCIETY
Meets on the first Tuesday of each month from November to June inclusive, at 8.15 P.M., at the British Institute of Radiology, 32 Welbeck St., London, W. 1.

ELECTRO-THERAPEUTIC SECTION OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)
Meets on the third Friday of each month during the winter at 8.30 P.M. at the Royal Society of Medcine, 1 Wimpole St., London, W. 1.

BRITISH INSTITUTE OF RADIOLOGY
Secretary, Dr. John Muir, 32 Welbeck St., London, W. 1.
Meets at 32 Welbeck St., but regular dates and times of meeting have not yet been arranged.

MEETING OF SCANDINAVIAN ROENTGEN SOCIETIES

Dr. Forssell has recently sent to the Journal the following information with regard to radiological societies in Scandinavian countries and Holland:

Society of Medical Radiology of Sweden—Meets in Stockholm.

Society of Medical Radiology of Norway—Meets in Oslo.

Society of Medical Radiology of Denmark—Meets in Copehagen.

Society of Medical Radiology of Finland—Meets in Helsingfors.

Dutch Society of Electrology and Roentgenology—Meets in Amsterdam.

All of the above societies have their meetings, as a rule, every second month except in the summertime. The Scandinavian societies have also formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

CORRESPONDENCE WITH THE ACTING DEAN, UNIVERSITY OF ILLINOIS SCHOOL OF MEDICINE, ON "APPOINTMENT OF PHYSICIST AS PROFESSOR OF ROENTGENOLOGY"

To the Editor: I note with interest the editorial which appeared in the January, 1925 number of the American Journal of Roentgenology. The editorial is entitled "The Appointment of a Physicist to the Department of Roentgenology." The name of the institution is not mentioned, but of course, it seems to be very generally understood that you refer to the University of Illinois College of Medicine. I fear, too, from the statements that are made in this article, an entirely erroneous impression may be conveyed to the profession at large. I am, therefore, writing to you the actual facts in the case, and I would be very glad if you see fit to have these facts printed in the Journal, and you may feel free to refer to the University of Illinois.

I will say that according to the 1924-1925 catalog, we have a division of Roentgenology, which appears under the department of Medicine. Dr. Charles Spencer Williamson is professor and head of this entire department. This includes Internal Medicine, Pediatrics, Roentgenology, Neurology, Psychiatry and the History of Medicine. In the division of Roentgenology are: Dr. Hartung, assistant professor, Dr. J. J. Litschgii, instructor, and E. J. Giryotas, technician.

Heretofore, our *x*-ray work has not been fully organized. Dr. Hartung has spent a few hours a week in the dispensary in the old building where the *x*-ray work of the college has been done. In connection with the opening of the new medical buildings, a considerable sum of money was set aside for an *x*-ray laboratory and for radiotherapy. In order to do this, the services of an expert in this field were required. In order to meet the needs both from the clinical side and also from the physical side in connection with this work, the plan was evolved of having two men of equal rank, one competent to carry on investigation in this field and another man trained in medicine and competent to handle the clinical side of the work and to carry on investigation. Since it was necessary for the University to proceed with the installation of an *x*-ray equipment, Dr. Albert Bachem was employed on a full time basis, with the rank of Professor and Director of the Laboratory, meaning, of course the physical laboratory. Dr. Bachem is a man trained in physics with the degree of Doctor of Philosophy and comes with the recommendation of such eminent men as Einstein and other noted physicists. He is not an M.D. and therefore cannot be licensed to practice nor to make diagnoses, nor to treat disease, according to law. The appointment of Dr. Bachem as a trained physicist was done with the understanding that another man of equal prominence would be appointed and given equal rank in this department, to conduct the clinical aspects of this work. These two men will be responsible for the work

along quite different lines and there should be no conflict. Of course, mutual cooperation will be necessary.

Yours very truly,
D. J. Davis, Acting Dean.

Chicago, Ill.,
March 9 1925.

Dr. D. J. Davis, Acting Dean,
University of Illinois,
College of Medicine,
Chicago, Ill.
Dear Doctor Davis:

I am very glad to receive your letter of March 9 with regard to our editorial on "The Appointment of a Physicist to the Chair of Roentgenology," and I shall see that it is published in an early number of our Journal.

The editorial was written, not in a spirit of captious criticism, but because a principle is involved which is of the utmost importance to roentgenologists, and we believe to general medical progress in so far as it is affected by roentgenology. We look upon roentgenology as a branch of clinical medicine requiring a thorough knowledge of pathology and other fundamental medical subjects and in addition a broad training in general medicine. It is a fact that the roentgenologist now comes into contact with nearly every branch of medical practice. He has done his most useful work where he has been received as a consultant, the position for which he has earnestly tried to fit himself. He has come to the time when he believes that any lesser conception of his position relegates him to the status of a technician and largely destroys his usefulness. It is for this reason that he decries the use of the term "roentgenologist" and especially "Professor of Roentgenology" to designate a person without medical training. He, of course, recognizes the desirability and even the necessity for such work and teaching as only men like Dr. Bachem can do but he thinks it not unreasonable to ask that such a teacher be given the title of Professor of Bio-physics or some similar title which would really designate his true status, and would correspond to his qualifications. It is not merely a question of names with him but of insistence on the principle that an essentially medical subject should have as the head of its teaching force a person with medical training.

We wish that your great institution could see this subject from the viewpoint of those who have made roentgenology their life work and who are convinced that it is a backward step to appoint any but medically trained men in charge of what we believe to be a department of clinical medicine.

Very sincerely yours,
A. C. Christie, Editor.

Washington, D. C.,
March 17, 1925.

ADMINISTRATION OF TETRAIODOPHENOLPHTHALEIN THROUGH DUODENAL TUBE

To the Editor: Supplementing Dr. Carman's very excellent editorial on cholecystography published in the February number of the Journal we would like to announce that we have successfully visualized the gall-bladder in three cases following the injection of a solution of tetraiodophenolphthalein sodium salt into the jejunum through an ordinary duodenal tube; there were no reactions; one had a vomiting attack of short duration and another a slight diarrhea. The detail of the gall-bladder was even more sharply brought out than we have seen in many cases following the intravenous injection of tetrabrom.

The work is continuing and we are confident that we will get away from the intravenous method and much of the toxicity, both of which have been the objectionable elements to this wonderful advance.

We are also investigating the oral method of administration. So far it has not proved as reliable as when given through the tube and it is liable to excite severe vomiting. Some inventive genius will no doubt give us a pharmaceutical preparation of the tetraiodo which will pass safely through the stomach and not be absorbed until it reaches the jejunum—then the *teebnique* will be solved.

New York City, Sincerely yours,
March 16, 1925. Wm. H. Stewart.

REFORM IN RÖNTGENOLOGY

The field of röntgenology is a fertile one for the charlatan. Steps have already been taken by various communities—New York City among them—to meet this evil, but much more is to be done than the passage of laws requiring the licensing of röntgen laboratories.

The American Journal of Roentgenology and Radium Therapy has recently made a plea through its editorial columns for the inauguration of a crusade for reform in the field of röntgenology similar to that undertaken by the American Medical Association in the field of drugs. The journal purposes to have a "column" in which information and suggestions along these lines will appear. A request is made for advertisements, circulars and general information from all legitimate sources about practitioners of röntgenology who should not be practising.

Such a step toward a needed reform should receive the cooperation of all self-respecting practitioners of medicine.

(Editorial in *Medical Journal and Record*, March, 1925, page 309.)

THE AMERICAN RADIUM SOCIETY

The tenth annual meeting of the American Radium Society will be held in Atlantic City on Monday and Tuesday, May 25th and 26th.

The program is not yet completed but copies will be mailed to members at an early date, and non-members may have copies mailed to them by writing the publishers of *The American Journal of Roentgenology and Radium Therapy*.

Arrangements have been made for a scientific session covering all phases of radium work. Papers dealing with physical and biological research will be presented. A special effort has been made to center discussion around some of the more important groups of cases in which radium is applicable, by having a number of papers dealing with different angles of the same subject.

It is felt that this will induce a much more satisfactory discussion than that which usually accompanies a single presentation. Prospects are bright for the largest and most active meeting in the history of the society.

DEPARTMENT OF TECHNIQUE

Department Editor: DAVID R. BOWEN, M.D., Pennsylvania Hospital, Philadelphia, Pa.

In this department will be published from time to time, as material is available, suggestions for improvement in technique.

A CONVENIENT DOSAGE CHART

BY FRANCIS CARTER WOOD, M.D.

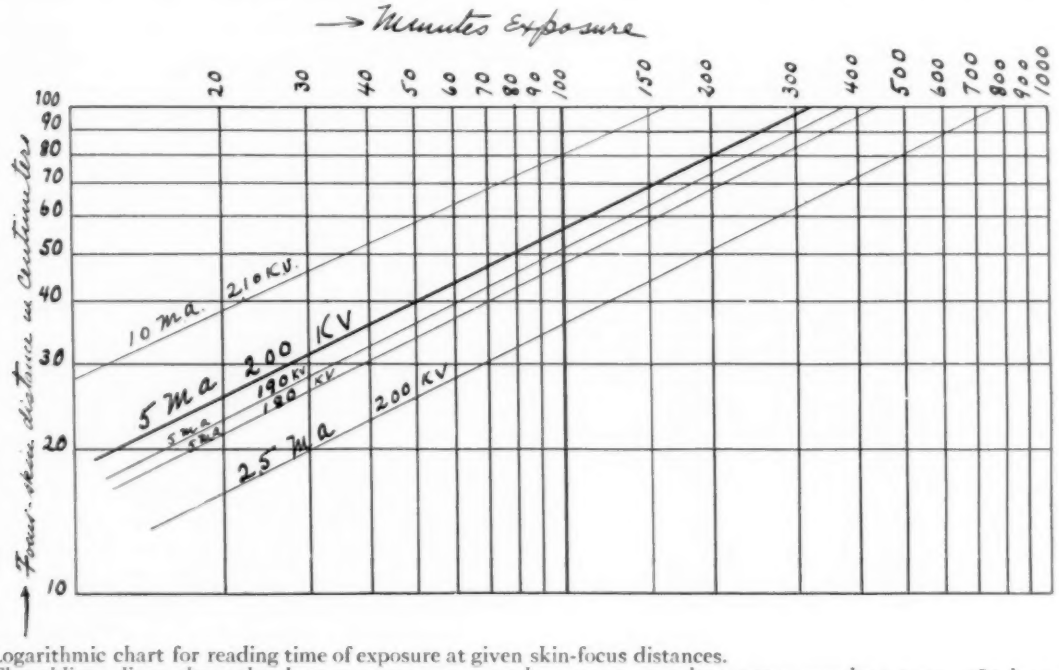
NEW YORK CITY

IN using roentgen-ray tubes in oil tanks the weight of the oil and the lead lining of the tank renders the apparatus so bulky that it cannot be raised or lowered without the installation of costly and cumbersome apparatus. If the tank is fixed and a definite radiation distance be employed the table must then be made adjustable. As such tables are expensive I have devised for St. Luke's Hospital a convenient and inexpensive system which avoids the expense of purchasing two elaborate tables.

Two light wooden tables on ball-bearing piano rollers were built for me by a carpenter at a price of about $50.00 each. One is 10 cm. higher than the other. With the mattress which rests on them a patient of ordinary thickness will be either 55 or 65 cm. from the anticathode. An additional mattress will shorten this distance, or the removal of one mattress will increase it 10 cm. But these are convenient average distances for high voltage therapy.

Running the tubes at 200,000 volts and 5 ma., the only thing which has to be done after adjusting the patient is to measure the skin-focus distance, this being the only variable.

A stiff cloth tape is creased at a point which represents the distance from the anticathode to the bottom of the tank. With the tape folded and touching the bottom of the tank, the distance to the



Logarithmic chart for reading time of exposure at given skin-focus distances.
The oblique lines show the dosages at 10 ma., 210 kv.; 5 ma., 200 kv.; 5 ma., 190 kv.; 5 ma., 180 kv.; 2½ ma., 200 kv.
For simplicity in reproduction only the round numbers have been drawn in. The commercially ruled logarithmic paper has much finer subdivisions, so that minutes can be estimated for any given centimeter.

patient's body is measured and the time of exposure determined by the accompanying chart (Fig. 1).

This chart is an expression of the inverse square law, which, as I showed a number of years ago, is not only true when measured by instruments but equally so when measured by the killing dose on mouse tumors. The validity of this law has been found to be approximately true with these tanks, the slight variation being due to the scattering from the oil. The dose charts are made on double logarithmic paper, which can be purchased from any dealer in drawing materials. A single point has to be known and this is the erythema for one distance with the filter which is being used. My own practice is to use 90 per cent of this erythema as a standard so that no patient runs any risk of getting an erythema unless that is desired. The distance is marked on the ordinate, the time on the abscissa. If, for example, the 90 per cent erythema dose at 40 cm. is 50 min., the 90 per cent erythema dose at 80 cm. will be four times this, or 200 min. A line is drawn in ink through these two points and a 90 per cent erythema dose for any given distance will then be instantly found by tracing from the point on the chart corresponding to this distance until the line is struck, then reading vertically the time in minutes will be found.

This chart can be made for differing milliamperes by simply drawing lines parallel to the first one. Thus, if 6 ma. are used and the suberythema dose for 5 ma. is 50 min. at 40 cm. then the new dose will be at the same distance $\frac{5}{6}$ of 50 min., or 41.5 min.; if 8 ma. are used, 31 min.

Voltage dosage is more difficult to compute because the filtered yield from the tube does not vary directly with the voltage. But if an ionization chamber of any type is placed in the beam and a reading taken at 200, 190, and 180 kv. the ratio of the deflections on the galvanometer or the times on an electrometer will give relative values quite accurate enough for clinical dosage. Another chart can be drawn giving the doses for the different voltages. It is better, however, not to have too many lines on such charts in order to avoid the possibility of error in reading.

It must also be remembered that if resistance is used instead of full autotransformer that the same amount must always be inserted as that with which the chart was made, for different yields will be obtained with different amounts of resistance. It is very convenient, however, to have a set of voltage charts because with many types of treatment it is quite unnecessary to use 200,000 volts. The wear and tear on the tube is much less if the voltage can be dropped to 190,000 or 180,000 volts to suit the type of treatment desired.

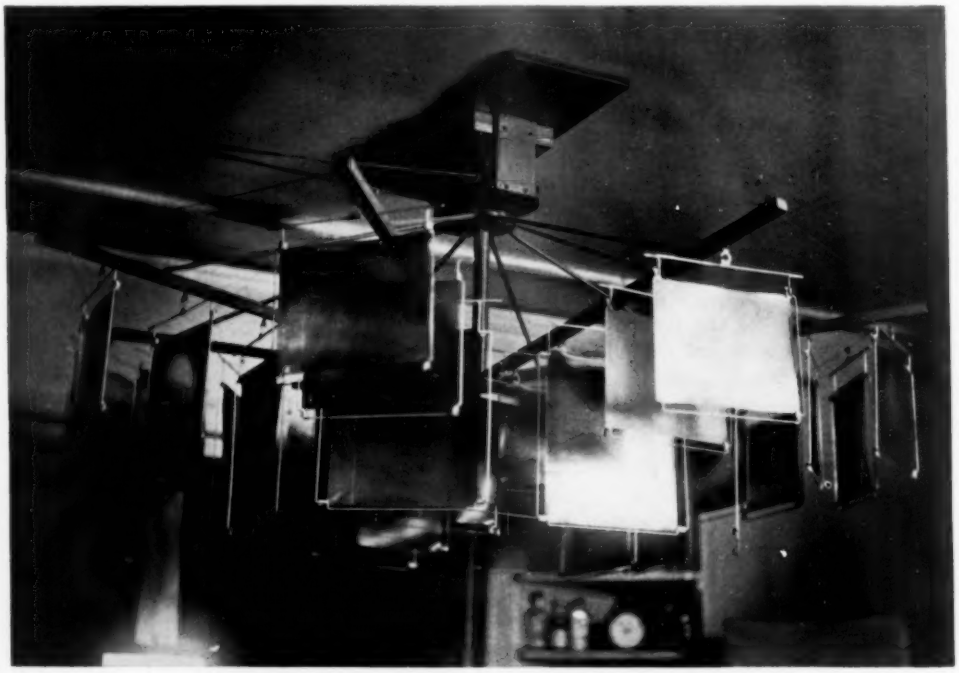
A NEW DEVICE FOR DRYING FILMS*

BY GEORGE E. PFAHLER, M.D.

PHILADELPHIA, PENNSYLVANIA

THIS device was developed in 1920, and has served us very well since that time. It has been shown to a number of my colleagues who have visited me and the practicability has appealed to all. Nearly all roentgen laboratories, no matter how large, soon find their space crowded and as work increases, and as we gradually increase the number of films used in each particular examination, additional drying space is needed. The floor space is usually completely occupied. Therefore, we hang this device from the ceiling. In principal it is the ordinary ceiling ventilating fan with multiple arms from which the films are hung, using the racks which hold the film while washing.

In this instance we have arranged a ball bearing wheel on the ceiling to which 8 wood arms are attached. Each arm is 3 ft. long and contains 6 screw-eyes in which the film racks are hung. The rotating dryer is run by an ordinary electric fan motor to which a pulley has been attached. The speed is reduced by means of a larger pulley on the ceiling. The several speeds on the fan regulator permit us to regulate the speed of the dryer.



Drying device, showing attachment to the ceiling, run by a pulley (to reduce the speed) from a fan motor. The manner of the attachment of films can be easily seen. It will be noted that the arms of the fan are braced with wire running through the device so as to give it increased strength.

The advantages of this arrangement are: (1) economy of space; (2) drying at the top of the room where there is less dust; (3) the centrifugal force throws off the excess of water, creates movement in the air as well as passing through the air and gives an even drying.

* Read at the Sixth Annual Meeting, Eastern Section, AMERICAN ROENTGEN RAY SOCIETY, Atlantic City, N. J., Jan. 22–24, 1925.

BARIUM SULPHATE PLASTER FOR PROTECTION AGAINST TWO HUNDRED THOUSAND VOLT ROENTGEN RAYS

BY L. R. SANTE, M.D., F.A.C.P., AND TRACY HINKLEY, B.S.

ST. LOUIS, MISSOURI

PLASTER made of barium sulphate for roentgen-ray protection is not new. In 1922 Béclère, Chevrotier and Lumière[1] used this material, for protection against low voltage roentgen rays, and since then numerous attempts—published and unpublished—have been made by others, some using compressed bricks or slabs of barium plaster, others applying the material to a wall surface.

In the construction of the new Radiological Department of the St. Louis City Hospital the problem of protection against 200,000 volt roentgen rays came up, and the possibility of the use of barium sulphate plaster was considered. Numerous experiments were made with various mixtures of barium sulphate powder, portland cement and sharp sea sand. These all proved of little practical value for roentgen protection, since either the large amount of ordinary sand present rendered the barium content so slight that sufficient protective value was not afforded; or where a large amount of finely powdered barium sulphate was used, the resulting plaster was so brittle that large cracks would appear on drying.

Where *barium sulphate sand* (95 per cent barium sulphate) was used as a substitute for ordinary sand both of these objectionable features disappeared. Barium sulphate sand is a hard, coarse, inert material which, when combined with portland cement, makes a plaster which on drying is almost as hard as concrete. A certain amount of finely powdered barium sulphate was used to increase the opacity of the substance in the mixture used in our department. This seems hardly necessary, however, since the barium content of the coarse sand is sufficient to produce practical protection, the resulting plaster would be even harder and more durable if the finely powdered barium was omitted. The following specifications were used in the construction of the walls of our therapy department.

[1] BÉCLÈRE, H., CHEVROTIER, J., and LUMIÈRE, H. Protecting bricks for roentgen work. *Bull. Acad. de méd., Par.*, 1922, lxxxvii, 255–257.

SPECIFICATIONS FOR THE BARIUM PLASTER PARTITIONS

The plaster shall be composed of portland cement, pulverized barium sulphate and coarse barium sulphate sand, thoroughly mixed and applied in coats not to exceed ½″ each, each coat to be scratched and allowed to dry before applying the succeeding coat. The cement and barium shall be mixed dry and sufficient water added to make a workable mortar. The under coats shall be composed of 1 part portland cement, 1 part fine barium sulphate and 2 parts barium sand. The finish coat shall be composed of 1 part lime putty, 1 part plaster of Paris and 1 part fine barium sulphate trowelled smooth and hard. The fine barium sulphate shall be 98 per cent pure, and the barium sulphate sand 97 per cent pure. Samples of the material will be taken and tested before using. The first and second coats shall have an adequate supply of fiber added. (On subsequent consideration it would seem that 1 part Portland cement and 3 parts barium sand should give an even more desirable mixture as far as strength is concerned.)

The partitions are made solid 2½ inches thick, plaster applied to a construction of light steel channels (1″) covered with metal lath on each side.

This plaster can be applied directly to wood or metal plaster lathing and if thick should be applied in several layers, each allowed to dry and roughened before the succeeding coats are applied. If desired a finishing coat of ordinary plaster may be used in place of the barium containing mixture. Where too much powdered barium is used the plaster may be quite brittle, and any fastenings or hangings

applied to the plaster should be applied by bolts running through the wall and not by screws or nails driven into the partition. Our partition is 2½ inches thick and is applied to metal plaster lath. It has been standing for over one year and has showed no evidence of cracking or other deterioration. Measurements made of its roentgen-ray protective power show it to be equivalent to approximately ¼″ of lead to 200 kv. Measurements were made by means of Bachem's electroscope and also by a specially constructed electroscope having ½″ lead protective walls on all sides.

The therapy room has been in use since its construction and has proved perfectly satisfactory.

It is conceivable that this method of protection could be used in the ordinary plastering of office buildings as a protection to adjoining tenants, in rooms where roentgen rays were to be used. Much thinner coatings could be used as effectual protection against ordinary voltage roentgen rays. We have utilized this for the protection of our entire photographic department—barium plaster of this composition has been applied to brick and tile walls with perfect satisfaction.

A CORRECTION

The Department Editor regrets a serious omission from the Trudeau Sanitorium exposure chart, as published in the February issue. The factors omitted were: 30 ma., 5½-inch spark gap between points, radiator type tube.

BOOK REVIEWS

Books Received Are Acknowledged under Heading: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

MEDICINE: An Historical Outline. By M. G. Seelig, M. D., Professor of Clinical Surgery in the Washington University School of Medicine. Cloth. Price, $2.25. Pp. 207, with 48 plates. Baltimore: Williams and Wilkins Company, 1925.

This little volume is not intended as a complete or encyclopedic history of medicine but is a very clear and concise account of the development of medical art and science from primitive times to the twentieth century. Although the book is composed of lectures it makes a continuous story that is very readable and unusually interesting. Enough of general history and just a sufficient number of dates are woven into the story to keep the reader well oriented.

One of the principal reasons why so many physicians have nothing more than a mere smattering of knowledge of the history of medicine is the apparent vastness of the subject when an attempt is made to read a comprehensive medical history, such, for instance, as the admirable one of Garrison. The reader is soon lost in a vast forest of names and dates. Dr. Seelig, evidently from a comprehensive knowledge of medical history, has selected just those names and dates that seem to give continuity to the story and that emphasize the important epochs in the progress of medicine. By such a continuous story the reader not only gains a good general knowledge of medical history but he is led to such a comparison of the knowledge and practice of various early times with those of his own that he is afforded an improved basis for judgment of his own wisdom and skill. If he reads with any discrimination at all, he must agree with Dr. Seelig in the following quotation: "The human mind is peculiarly prone to error. The emotional in man leads him almost inescapably towards superstition and mysticism. How natural then that in his earliest gropings towards the light, man confused the essential facts of pitilessly cold logic with the inner springs of action of his own powerful impulses. How natural for him to fall into error, not only in the far long ago, but even in the present era of supposed enlightenment. As a matter of fact, it is questionable if man is much less primitive today than he was ages ago. He is merely more restrained and more inhibited by the very conventions that his own superstitions have helped establish for him. If we grant this, if we bring ourselves to regard the development of medicine through her primitive swaddling clothes stage as a part of her journey through difficulties to the stars, then we shall have learned the first essential lesson for physicians, namely—tolerance. Tolerance in turn furnishes equanimity, a priceless attribute of the medical mind."

Dr. Seelig has accomplished a thing that deserves praise—he has written a history of medicine that is *interesting*, and perhaps the greatest value of the little book lies in the fact that it will serve to stimulate many of us to the study of medical history in the more comprehensive works. A. C. C.

ATLAS CHIRURGISCH-PATHOLOGISCHER RÖNTGENBILDER. Von Prof. Dr. Rudolf Grashey, Chefarzt der physikalisch-medizinischen Abteilung des städtischen Krankenhauses München-Schwabing. Lehmanns medizinische Atlanten. Band 6. Second edition. Cloth. Price, $5.60. Pp. 185, with 471 illustrations München: J. F. Lehmann, 1924.

The long awaited second edition of the well known and much sought after book by Grashey has appeared at last. External circumstances were responsible for the delay in its publication. In order to keep the price of the work within reasonable bounds, the author was compelled to forego the photographic reproduction of the illustrations and to content himself with autotypes. The slight reductions in size and the glossy finish employed, however, make this disadvantage appear rather small, and the reproductions are quite adequate for their purpose.

The roentgenograms are increased by 231 and the drawings by 43 over those in the first edition. The "Summarizing Text" in the first part has become a small and valuable textbook of 58 pages with instructive sketches and numerous references to the literature which facilitate further study by anyone desiring to inform himself more fully upon particular questions.

The choice of illustrations has been very skilful, and in addition to the ordinary pictures important to the beginner, the expert will find examples of all kinds of the rarer findings as well. The latter are contained in the second part which comprises 125 pages of roentgenograms and adequately instructive comments.

A "Summary of Pictures and Illustrations According to Location in the Body" and an index facilitate prompt location of any subject that needs to be looked up.

The work is indispensable for the beginner, and also of value to the experienced worker. It will provide stimulation, comparative pictures and information even to the roentgen expert.

The work of the publishers is satisfactory.

F. Haenisch.

BOOKS RECEIVED

TUMORS OF THE SPINAL CORD AND THE SYMPTOMS OF IRRITATION AND COMPRESSION OF THE SPINAL CORD AND NERVE ROOTS; PATHOLOGY, SYMPTOMATOLOGY, DIAGNOSIS AND TREATMENT. By Charles A. Elsberg, M.D., Professor of Neurological Surgery, Columbia University; Consultant in Neurological Surgery, Presbyterian Hospital; Attending Surgeon, Mount Sinai Hospital, and Neurological Institute, New York City. Cloth. Price, $10.00. Pp. 421, with 354 illustrations. New York: Paul B. Hoeber, Inc., 1925.

INTERNATIONAL ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

AMBERSON, J. BURNS. The significance of roentgenographic pleural annular shadows. *Tubercle, Lond.*, August, 1924, v, 534–551.

Clinically, the characteristic and localizing symptoms attending the development of pleural annular shadows are conspicuous for their absence. This points to a pleurisy rather than a pneumothorax as the underlying lesion. It has been established that these annular shadows develop and increase in size as accompaniments of active disease in the subjacent lung and that they contract and fade as this activity subsides. There is good evidence that the roentgenographic pleural annular shadow as an accompaniment of pulmonary tuberculosis is a reality.

Complete and exact proof of the significance of these shadows is still lacking, but it appears that most of them represent simple limited pleurisies not differing fundamentally from the usual chronic or subacute tuberculous inflammations. The lesion is sometimes associated with separation of the pleural membranes and the resulting interstices may contain fluid. The true incidence of perforation of the tuberculous lung into a small intact pocket of pleural adhesions is an open question.

To throw light on this important clinical problem there is need for autopsy examination after the lesions have been localized by the roentgenogram and with the special conditions kept in mind.

BARCLAY, A. E. A large pure uric acid renal calculus. *Brit. J. Radiol.*, (*B.A.R. P. Section*), March, 1924, xxix, 73–76.

Stones in the kidney containing even a small proportion of uric acid are rare and so far as is known the following is the first case reported in which a pure uric acid stone was found in a kidney. The patient, a muscular man, aged fifty-five, complained of some pain now in the right and now in the left loin, with a little blood in the urine but no pus. The roentgen plates were perfectly satisfactory and showed no shadows suggestive of calculus although they showed the kidney outlines sharply defined and symmetrical.

The patient was about to leave the nursing home when blood again appeared in the urine and he was hurriedly cystoscoped. Blood was seen issuing from the left ureter and consequently the left kidney was explored and the stone removed from the pelvis at the entrance to the ureter. The patient made a satisfactory recovery and has had no further urinary symptoms. The roentgen plates were again scrutinized carefully and not the slightest suggestion of a shadow could be detected to correspond with this stone which measured 1 inch long by more than one-half inch thick and wide. In its thickest part this stone had a roentgen opacity of less than 1.5 mm. Al. The stone was analysed by A. Haworth who reported that it consisted wholly of uric acid.

It is fortunate that this type of stone is such a rarity since its roentgenographic detection appears impossible. It is suggested that pyelography may aid in the detection of this type of calculus.

BLOODGOOD, JOSEPH C. The differential diagnosis of periosteal bone lesions. *Radiology*, November, 1924, iii, 432–433.

The first differentiation between a central and a periosteal bone lesion is made by palpation; and with the rarest exception one should make the differential diagnosis by palpation alone. The periosteal lesions of benign character which roentgenologically and by palpation suggest the possibility of periosteal sarcoma are: ordinary fracture, fracture of the beak-shaped process of the tibia (Schlatter-Osgood disease), tuberculosis and syphilitic periostitis.

It is very unusual to see fracture in periosteal sarcoma except in the late stage, when diagnosis presents no difficulties. Here the roentgenogram shows absence of the marrow shadow "bone callus" of new bone formation of less diameter than the periosteal shadow. Tuberculosis usually involves two or more bones in the neighborhood of the joint and such a multiple involvement practically excludes sarcoma. Very many cases of syphilitic periostitis with or without involvement of the marrow of the shaft give the clinical picture of sarcoma, palpate like sarcoma and in the roentgenogram are difficult to differentiate from sarcoma. As a matter of fact, limbs have been amputated on the diagnosis of sarcoma when the lesion was really syphilitic periostitis. Extirpation for biopsy does not always aid in diagnosis because the inflammatory tissue of syphilis resembles somewhat lymphosarcoma. In diagnosis attention should be paid to the Wassermann reaction, and even if this should turn out negative a preliminary treatment with salvarsan should be tried; if the bone lesion

does not then show improvement there is fairly sound justification for fixing the diagnosis as periosteal sarcoma.

CALVÉ, JACQUES. A localized affection of the spine suggesting osteochondritis of the vertebral body, with the clinical aspect of Pott's disease. *J. Bone & Joint Surg.*, January, 1925, vii, 41–46.

A discussion is presented of an affection of the spine which bears a relation to the spinal column like coxa plana to the hip, and Köhler's disease to the foot. One case was observed by the author and the second reported with permission of Dr. Brackett. The children affected were two and one-half and seven years old, respectively.

There seemed no reason for doubting the diagnosis of tuberculous affection of the spine until the first roentgenograms were studied sometime after the onset. These showed that the lesion attacks only one vertebra, there being but one pedicle. In Pott's disease there are always at least two pedicles and at least two vertebrae affected or destroyed. In the present cases the intervertebral discs were absolutely intact which is not the case in Pott's disease, and the cartilage was thicker and there was a neoformation of this tissue which is never seen in tuberculosis. There was also evidence of increased bone density.

These observations suggested more careful tests for tuberculosis which turned out to be negative. The Wassermann reaction was also negative.

CARMAN, RUSSELL D. Technical aids in the roentgenologic demonstration of lesions high in the stomach and on the posterior wall. *Radiology*, January, 1925, iv, 33–39.

Among the lesions most likely to elude observation with the ordinary roentgenographic procedure are those of the posterior wall and those high in the stomach. The niche of an ulcer in the upper or middle third of the stomach remote from the curvature may not be observed either in the dorsoventral or oblique views. A few of the technical adjuncts for demonstrating such lesions easily are: (1) observation of the contrast meal as it enters the stomach during gastric filling; (2) careful inspection of the sulci between the rugae when demonstrable; (3) palpatory maneuvers to approximate the anterior and posterior walls of the stomach and thus reveal a small central filling defect or niche or elicit abnormalities in the cardia; (4) examination in the Trendelenburg position, and (5) roentgenography in the oblique or transverse view.

In observing the stomach as it fills only the first few swallows of the contrast meal need be observed, but the inspection must be close. The important point is that normally the stream from the esophagus does not wander about haphazardly but folllows a direct course in the upper portion of the stomach until it impinges on the gastric wall, and then descends. A tumor high on the posterior wall usually deflects the whole stream noticeably to one side or it may divide the stream. The crater of the ulcer or deeply ulcerating cancer in this situation commonly fills. After the stomach is filled the tumor or ulcer is submerged and it may be impossible to bring the lesion again into view. If the pylorus is obstructed and the stomach contains much secretion, the barium column falls through the secretion in "blobs" which follow no constant path.

To visualize the grooves and rugae of the gastric mucosa the patient is given a few swallows of the aqueous barium mixture and this is distributed thinly over the stomach by stroking palpation. In the region of the gas bubble no furrows are seen. Below it they are visible as far as the pylorus, running mainly parallel with each other and with the curvatures. Transverse grooves may be noted but these are quite short. The average number of longitudinal furrows in the pars media seems to be about ten. Converging folds are observed in cases of spastic or organic hourglass stomach produced by a lesion. In a few cases there were noted normal or perhaps somewhat intensified parallel sulci with a niche in the course of one furrow. Since the rugae are obliterated in the immediate area of a tumor or the crater of an ulcer, a localized absence of sulci should be regarded with suspicion.

Palpatory pressure to bring the anterior and posterior walls near together, thin the opaque ingesta and thus show abnormalities of the wall. It can be accomplished most conveniently by slow stroking movements of the fingers downward over the stomach during the process of filling. During this manipulation tumors of the posterior wall appear on the screen as translucent areas within the gastric silhouette corresponding in size and shape to the growth. The excavation of an ulcer appears as a dense spot usually circular, and by turning the patient to the oblique or transverse view a projecting niche may be disclosed. An ulcerating cancer, under such conditions, usually shows a central opacity within an encircling translucency corresponding to the margin. As a rule the concavity of the ulcerating cancer does not extend into the gastric wall so there is no projecting niche at any angle of view. The view of palpation during roentgenoscopy cannot be emphasized too strongly.

Experience has shown that the employment of the Trendelenburg position during roentgenoscopy to examine the cardia will succeed in disclosing a small tumor or ulcer when other positions fail.

In roentgenograms taken with the left side to the plate the anterior and posterior contours of the upper part of the stomach can be seen with fair definition. In this position, of course, the lower portion of the gastric outline is overlapped by the shadow of the antrum and duodenum, so that an apparent deformity in these regions must be judged with caution.

CLARKE, T. WOOD. The value of gastrointestinal *x*-rays in the diseases of children. *Arch. Pediat.*, December, 1924, xli, 840–844.

A thorough gastrointestinal examination by the roentgen ray is a valuable adjunct to clinical examination and blood, stool and stomach analyses in the clearing up of gastrointestinal abnormalities in the child. An appeal is made for the same roentgenoscopic attention to the child's abdomen which is becoming more universally accepted as a routine procedure for the adult.

The early recognition of intussusception can be accomplished roentgenoscopically with the aid of the barium enema. Whenever a normally healthy infant suddenly shows vomiting and collapse, the symptoms usually associated with intussusception, a roentgenoscopic examination of the colon should be made without waiting for the characteristic bloody and mucous stools; and thus many of the tragedies of belated operations for intussusception can be averted. Observation of the steady ascent of the barium through the sigmoid and descending colon with a sudden and complete stoppage of its progress in the transverse or ascending colon with, in some cases the thin line of barium as it slips by the side of the intussusception gives an unmistakable picture. In 2 cases the author reports that the action of the barium convinced him that the enema reduced the intussusception before his eyes.

The diagnosis of congenital pylorospasm or pyloric stenosis in young infants can be made with the aid of the roentgenoscope. Presence of the stenosis and its variety can be determined in a few hours by the barium meal (given either from a bottle or by means of a catheter used as a stomach tube) and a series of roentgenograms. A stomach emptying in two hours can be said to be free of the complaint; one holding barium from two to four hours is a mild degree of pylorospasm, and one still retaining barium in any appreciable quantity after four to five hours can be diagnosed as probably a severe grade of pylorospasm or an organic pyloric stenosis. Four-hour retention, however, must not be considered an absolute indication for immediate surgery as such cases with appropriate care may recover without operation.

Between the first and second years of life some children suffer from an intestinal complaint recently called "celiac disease," characterized by extreme emaciation and enormous abdominal distention. Roentgen-ray examination discloses tremendous and uniform distention of the entire colon and differentiates the condition quite clearly from tuberculous peritonitis or Hirschsprung's disease.

In children of school age there occur types of dyspepsia, cyclic vomiting and indigestion, the causes of which are often disclosed by roentgenoscopic examination of the gastrointestinal tract. Adhesions about the pylorus may be suggested by absence of the duodenal cap, and adhesions about the appendix by retention of the barium in the cecum after forty-eight hours. Sometimes an old chronic appendix is disclosed in cases in which appendicitis was not even suspected. It is the author's experience that a shadow of the appendix shown four days following barium by mouth is a most valuable aid in determining the presence of a chronic inflammation of the appendix. Chronic digestive disturbance, especially amongst school children which is now attracting the attention of pediatrists is that due to enteroptosis as the result of bad posture. The result is intestinal stagnation with or without constipation, recurrent attacks of headache, vomiting and sometimes even attacks of high fever. In such cases a rectal injection of barium with roentgenograms taken both prone and erect will in many cases confirm the diagnosis of enteroptosis and often show definite twists and kinks in the elongated and dilated colon.

DANDY, W. E. Localization of brain tumors by injection of air into the ventricles of the brain. *J. Missouri State M. Ass.*, October, 1924, xxi, 329–331.

Brain tumors are very frequent lesions affecting the central nervous system between the ages of two and sixty. Fifty per cent of brain tumors can be localized by neurological examination, and about 15 per cent more can be localized roentgenologically without air injections. Such roentgen-ray changes are: (1) deposits of calcium in tumors; (2) change in vascularity of the blood vessels of the skull, and (3) localized and more or less generalized destruction of the inner table of the skull.

In the remaining 35 per cent the injection of air can alone make the localization. It is a dangerous procedure and should be used only

when necessary. As a preliminary to the injection of air an opening is made in the skull on both sides so that either lateral ventricle can be reached. Fluid is then aspirated and exactly the same amount of air is injected in its stead. The air can be moved through the entire ventricular system in such a way that any part desired can be thrown as a shadow on the roentgen-ray plate. Therefore, given distorted shadows of the ventricles and comparing them with the normal, a localization can be made of the tumor causing the symptoms.

DAY, ROBERT B., AND MARTIN, HARRY W. Diverticula of the urinary bladder. *J. Am. M. Ass.*, Jan. 24, 1925, lxxxiv, 268–274.

The importance of diverticulum is emphasized by the fact that a badly infected, poorly draining diverticulum, especially with ammoniacal urine gives rise to subjective symptoms of dysuria, pain and distress of great severity. Two etiologic factors are mainly responsible for this condition: (1) embryologic defects in the bladder, and (2) obstruction (usually at the bladder neck). The authors have found in practically every case that there was some form of obstruction either a hypertrophied prostate, a contracture or a bar. There are numerous modifying factors that explain the diversified clinical aspects of different cases. These are situation, size of the orifice, size of the sac, number, presence of infection in various parts of the urinary tract and the bacterial type, focal infections, the nature and extent of the obstruction, secondary inflammatory changes in and surrounding the diverticulum, calculus formation and carcinoma.

In from 75 to 80 per cent of the cases the orifice is located near the ureteral opening, and in this type as bladder neck obstruction progresses one may observe the gradual increase in size of the diverticular sac if successive cystograms are made. Nearly every diverticulum with marked clinical symptoms is associated with prostatism, either hypertrophy or bladder neck contracture; and rarely the symptoms may be caused by ureteral obstruction. Surgical relief of the obstruction is necessary in almost every instance.

The relatively rare forms that require excision are the hour-glass bladder, and the large single diverticulum arising at or near the dome or on the lateral aspect high up near the vertex with the wall composed grossly of all the coats including the thick muscular wall. Histologically, the latter is found interspersed with fibrous tissue resembling the hypertrophied bladder found in advanced hypertrophy of the prostate. This muscular wall is merged into a semifibrous ring surrounding the orifice. Cystography is apt to mislead one as to the actual degree of retention that may take place even with a dependent drainage.

Brief descriptions are given of one case with the orifice near the ureteral opening, of 2 cases of hour-glass bladder, 2 cases of dome diverticulum and one case in which the orifice of the diverticulum showed a sphincter-like action.

DARLING, BYRON C. The sacro-iliac joint: Its diagnosis as determined by the *x*-ray. *Radiology*, December, 1924, iii, 486–491.

Roentgenograms made improperly are often misinterpreted as showing sacroiliac separations which do not exist. This is a common error and experienced roentgenologists are almost unanimous in recommending a conservative interpretation of such findings. Roentgenograms of the pelvis are at their best only when the pelvis is level and correctly centered in relation to the central roentgen ray. Since a degree of curvature of the spine is common, this may be difficult to attain. The stereoscopic shift should be vertical and not across the pelvis.

In the roentgenogram the ribbon or line of the cartilage space anteriorly over the joint is carefully examined, and this is followed down to its lower margin which runs backward towards its posterior articular surface. Usually the separation is said to be demonstrated by the increase in width of this ribbon on one side over the other, but often a careful inspection will show that the pelvis has been rotated toward the opposite side. This is disclosed by an increased breadth of the wing of the ilium on the opposite side with a definite foreshortening on the one side. Where there is actual separation of the pelvic girdle such as a complete fracture with displacement or a complete separation at the symphysis, then only will the roentgenogram show a definite sacroiliac separation or relaxation.

Such relaxation, subluxation or dislocation may exist clinically, but it cannot be shown definitely by roentgen-ray examination if and when the motion consists of a forward and backward tilting of the sacrum in relation to the ilium. It should also be remembered that the sacroiliac joint has a synovial lining and is therefore subject to arthritis due to any focal infection.

DIEST, HELLMUTH. Diagnosis of lung tumors. *Klin. Wchnschr.*, Nov. 25, 1924, iii, 2200–2206.

In the diagnosis of primary mediastinal tumors the roentgen picture is of minor importance. Absolutely different roentgenographic results are obtained in different cases,

although the symptomatology otherwise may be exactly the same, the differences being entirely due to the manner of local growth. These peculiarities are illlustrated in 4 cases, 3 of which were confirmed at autopsy. Lymphogranulomatosis may give exactly the same roentgen picture as a mediastinal tumor, the first roentgenologic sign in early cases being an externally concave shadowing of the sternum. The roentgen picture, however, together with the clinical symptoms may suffice for a diagnosis, but a diagnosis on the roentgen picture alone is exceedingly unsafe.

In the diagnosis of primary lung tumors, the roentgen finding is in general more uniform than in mediastinal tumors. In carcinoma of the upper lobes the roentgen picture shows the upper third of the lung field completely and uniformly darkened. The lower limit may be quite sharp. In carcinomas that are roentgenologically more in the middle or lower third of the lung field it was found that the intensity of shadowing is strongest medially and becomes less dense laterally toward the chest wall. This is usually the basis upon which the presence of an exudate may be easily excluded. Of course in those cases of carcinoma accompanied by an exudative pleuritis, the roentgenologic diagnosis of a carcinoma may be rendered impossible. The author states that he has observed a roentgen plate of a case of pulmonary syphilis which very closely resembled the typical picture above described for carcinoma of the middle and lower lobes.

In the 5 cases of primary bronchial carcinoma discussed, the diagnosis was established twice on biopsy and in the other 3 cases was established only at post mortem. The roentgenologic picture showed nothing characteristic. In secondary lung tumors the roentgen findings, if they are necessary for diagnosis, disclose small multiple shadows.

In the diagnosis of lung echinococcus the conclusion is based upon the roentgen findings, the blood findings and the demonstration of coughed up membranes.

Dunham, H. Kennon, and Skavlem, John H. *X*-ray observations of the pathogenesis of pulmonary tuberculosis. *Tubercle, Lond.*, February, 1924, v, 217–232.

The adult and juvenile types of pulmonary tuberculosis which are so clearly differentiated by the roentgen-ray chest plates have a firm foundation in anatomy, pathology and allergy. The infection enters the lung by the air passages or the blood stream and is carried to the lymphoid tissue which is directly connected with the lymph vessels. In the child, there is very little reaction except near the point of inoculation, and this is mostly interstitial; but there is a great reaction of the regional lymph nodes. In the adult there is comparatively little reaction of the lymph nodes but massive reaction around the infection with extensive exudate which floods a definite part of the lung. Thus, in the child which is not sensitized, the reaction to the tubercle bacillus is little like an inflammatory reaction, while in the adult the reaction is a severe inflammatory one and is seen upon the roentgen-ray plate as a lobular density under the pleura, shaped like a fan or a cone as it is confined by the lung structure. Pulmonary tuberculosis is a disease of successive infections, therefore of differing ages, which causes the fans to have differing densities that are easily recognized upon the roentgen-ray plate. In the series of roentgen-ray plates of a given patient the only tuberculous lung lesion observed to spread from the hilum to the periphery was tuberculous, caseous bronchopneumonia. This spreads by aspiration of droplets from open lesions and must not be confused with so-called perivascular or peribronchial tuberculosis.

Emphasis is placed primarily on the importance of the fans or cones in the roentgen-ray plate which is so constant in and characteristic of the adult apical type of pulmonary tuberculosis. Their differing densities and their definite location within the lung should be noted; and the importance of this finding should be contrasted with the conception of pulmonary tuberculosis as expressed by hilum and peribronchial tuberculosis. The latter are terms born of the false conception of the pathogenesis of pulmonary tuberculosis. It is contrary to our knowledge of anatomy, physiology and of the modern conception of pathogenesis of the disease.

Enfield, Charles D. Acromegaly following gigantism: Report of case treated by *x*-ray. *Radiology*, December, 1924, iii, 492–496.

Changes in the sella turcica demonstrable by the roentgen ray may or may not accompany acromegaly or gigantism. It would appear that conclusions ought rarely, if ever, to be drawn from the mere size of the sella or from its shape, which also varies quite widely in the normal. When enlargement produces changes either through tumor formation or simple hyperplasia which are definitelv demonstrable by the roentgen ray, these will be in the nature of erosion or destruction and not of mere enlargement or change in contour. Tumor formation or hyperplasia resulting in gross enlargement of the pituitary may or may not be a part of the picture of acromegaly or gigantism so that the absence of any demonstrable

change in the sella by no means stands in the way of a definite diagnosis of acromegaly or gigantism.

A report is given of a case occurring in a male, aged eighteen, who presented himself for examination because of a progressive malocclusion of the teeth, this being the sole presenting symptom. A roentgen-ray study was made of the head, the sella and the hands. The sella was of normal outline, showed no evidence of erosion and measured 10 mm. wide by 9 mm. deep; the hands showed uniform increase in width and length of all the phalanges, the epiphyses were united and there was slight tufting of the terminal phalanges, but there were no exostoses. The frontal sinuses were considerably increased both in area and in depth and were subdivided into a considerable number of small cells. The inferior maxilla was markedly enlarged and protuberant. Viewed laterally, the lower incisors projected 2 or 3 mm. beyond the plane of the upper incisors.

The above facts considered together with the general clinical findings suggested a diagnosis of a transitional form of hyperpituitarism, gigantism assuming acromegalic characteristics. The progressive growth of the jaw as well as the absence of weakness, the normal blood pressure and pulse rate and the normal fat distribution seemed to indicate that the gland was still over-functioning. The apparent activity of the condition called for some form of treatment but did not warrant surgical intervention. One roentgen treatment was given consisting of about one-half an erythema dose administered through two temporal and one frontal ports of entry, 200 kv., 5 ma., 50 cm. skin target distance through 0.75 mm. Cu. The patient did not return for further treatment but it was reported that the gigantism had not advanced any further.

GÄBERT. Technique of roentgenoscopy and roentgenography of the lung apex. *Klin. Wchnschr.*, Nov. 18, 1924, iii, 2144.

The method of Albers-Schönberg is applied to the examination of patients in the standing or sitting position. The patient is placed facing the tube with the focus directed at the jugulum. The patient is then directed to "slump" forward and at the same time extend the neck vertebrae by holding the chin as high as possible. The shoulders are sunk and the arms dropped down so that the intercostal spaces are freed from the disturbing shadow of the shoulder blades. In this position, the clavicles are projected caudally, and by slight shifts in the focus as well as forward or backward motion of the patient the widest possible projection of the intercostal spaces is sought. The diaphragm is closed to include only the apical areas.

By this technique the second intercostal space can be practically always made visible and the shadows of early pulmonary tuberculous foci become readily distinguishable. After adjustment to the best conditions for observing the pulmonary apical area a plate may be substituted for the screen in order to produce a permanent record.

GARDNER, BOYD S. The *x*-ray as a means of safeguarding the antrum of Highmore during extraction of teeth. *Radiology*, December, 1924, iii, 507–508.

The use of the pre-operative roentgenogram should be emphasized as a means of safeguarding the antrum when extracting teeth; and the postoperative roentgenogram is likewise necessary as it is the only means of ascertaining the presence of roots, pieces of processes or foreign bodies.

The roentgenograms do not always reveal the exact condition, yet they are the best means of determining the relationship of the antrum to the roots of the teeth. In patients with unusually large antrums the lingual root of the first molar is generally well separated from the two buccal roots, and the floor of the antrum drops between to the point of bifurcation. Hence the roentgenogram cannot reveal the exact relationship of the roots as they superimpose the lowest portion of the antrum. It is, however, possible to make a diagnosis if several exposures are taken from different angles.

GIBSON, ALEXANDER. Uncomplicated dislocation of the inferior radio-ulnar joint. *J. Bone & Joint Surg.*, January, 1925, vii, 180–189.

Perhaps the strongest of all joints are those that are ligamentously reinforced and that is why a dislocation of these joints is rare. It may occur as a complication of fracture but the uninvolved dislocation of a joint which depends for its strength on ligaments alone is not common, if we exclude the acromioclavicular joint. The inferior radio-ulnar articulation is such a joint and its dislocation is relatively rare in the literature. The dislocation might be produced by force applied in an abnormal direction so as to separate the bones or push one past the other. It might also be produced by force applied in a normal direction but excessive in amount. In the case described, the force causing dislocation was applied tangentially. The man was a laborer, aged forty-two. He was struck on the wrist while

the hand was in full supination. The wrist was held in supinated position; no pronation was possible, movement of the wrist and carpal joints were much diminished, and movements of the fingers were fair. The roentgenogram showed no fracture of the radius or of the ulna. There was no fracture of any of the bones of the carpus. The head of the ulna lay in front of the lower end of the radius, the whole head overlapping the radius, only the ulnar styloid being outside the radial shadow. In the roentgenogram the head of the ulna, the lunate bone, and the capitate made a straight line which was continued directly into the line of the third metacarpal.

An attempt to reduce the dislocation by manipulation was unsuccessful so seven to eight weeks after the accident open exposure was decided upon, and the patient was anesthetized. Dorsal incision gave an excellent exposure and the triangular ligament was found to have been torn away from the ulna while remaining attached to the radius. A periosteal elevator levered the displaced head into its normal position with the greatest ease. The dorsal radio-ulnar ligament was sutured into place, the hand put up in the position of almost full pronation with plaster of Paris. A roentgenogram taken about a month later showed practically a normal relationship of the parts and the patient was able to use his hand freely.

GRAHAM, EVARTS A., COLE, WARREN H., and COPHER, GLOVER H. Cholecystography. An experimental and clinical study. *J. Am. M. Ass.*, Jan. 3, 1925, lxxxiv, 14–16.

At the present time the substitution of tetraiodophenolphthalein for tetrabromphenolphthalein in clinical use is not advocated, although it is possible that further experience will make this substitution seem desirable. Sodium tetrabromphenolphthalein has been administered as an emulsion in olive oil, injected subcutaneously and intramuscularly and gall-bladder shadows were seen sometimes in rabbits but never in dogs. Administration in the form of a rectal drip is poorly tolerated but gall-bladder shadows have been obtained in human subjects and in animals. Certain sulphonphthaleins, fluoresceins, arsphenamin, mercurochrome-220 and a variety of other dyes were studied for their ability to produce gall-bladder shadows but none of them showed advantage over tetrabromphenolphthalein.

Clinically the latter compound is the most satisfactory for the roentgenologic diagnosis of gall-bladder disease. In the human being 4.5 or 5.0 gm. of the sodium salt is dissolved in 35 to 40 c.c. of freshly distilled water and filtered. It is then sterilized in a boiling water bath for 15 or 20 minutes. This dose is sufficient for a person weighing 125 lb. or more and should be reduced for lighter weights. The solution is given intravenously in two doses, one-half hour apart, before breakfast. Care should be taken not to allow extravasation of the dye solution because it produces tissue necrosis. All reactions and unpleasant sensations in patients have been transitory, even the severest reactions disappeared completely within a few hours. By using absolutely freshly distilled water, dye that has not undergone changes from exposure to light and air, clean glassware, and instituting ordinary care the reactions should be largely eliminated.

Certain orders for the patient are essential. Breakfast and lunch should be omitted, protein should be omitted from the evening meal. While awake the patient should take 2 gm. of sodium bicarbonate every three hours for 48 hours. The patient may have water by mouth and he should lie on the right side of the abdomen. The roentgenograms are taken 4, 8, 24 and 32 hours after injection.

The technique for making the cholecystogram follows: A radiator Coolidge tube is used with duplitized films, under double intensifying screens. The smallest practical diaphragm is used. Compression is made with the cone on the patient, who lies on his abdomen on the table. A flash exposure is made using 60 ma. with a 5-in. spark gap. The spark gap varies with the thickness of the patient. The Bucky diaphragm is not used.

HAYES, ROBERT H., and TROSTLER, I. S. Pathognomonic radiographic finding in early pulmonary tuberculosis. *Radiology*, December, 1924, iii, 474–478.

A digest of a preliminary report is given on a specific tuberculosis reaction produced by the injection of tuberculin, and observed roentgenographically. The shadow on the roentgen-ray film is the result of the focal reaction within the lung. If there is no tuberculosis present, no such reaction will occur, nor will the injection of tuberculin start up a reaction if some other disease is present and tuberculosis absent. Emphasis is laid upon the fact that the procedure is not a general one, but should be used only in cooperation with a tuberculosis specialist.

The type of case in which the test is necessary is the young adult showing slight or moderate toxic symptoms without any definite or local physical findings. First a von Pirquet test is applied to determine presence of active tuberculosis antibodies and also to serve as a control for the dosage of Old Tuberculin. A soft film

is taken of the chest using a modified Wasson technique as follows: Exposure 1/6 to 1/5 of a second, 25 ma., 84 kv. peak, 30-in. anode film distance. The film is developed at 65°F. (temperature must be absolute) in Eastman roentgen film formula.

After taking the first film, the O.T. is administered subcutaneously, and 48 to 72 hours later a second film is taken, using the identical technique. A physical examination is also made to determine if focal reaction has occurred.

The demonstration upon the second film of infiltration due to focal reaction is the diagnostic feature.

HEBERT, G. T. Annular shadows in pulmonary tuberculosis. *Tubercle, Lond.*, February, 1924, v, 212–214.

A case occurring in a boy aged sixteen is described and illustrated by four roentgenograms taken at different stages. There was active pulmonary tuberculosis and a faint suggestion of annular shadow in the right lung. A month later the roentgenogram showed spread of the disease in the right lung and the appearance of an annular shadow. There were no physical signs of cavitation. Artificial pneumothorax was performed and the annular shadow was found to have increased in size. Anteriorly the lung was in contact with the chest only at the site of the annular shadow.

In the present case the evidence indicates that the annular shadow was caused by some change in or on the visceral pleura. The conclusion is based on the fact that the shadow occurred about the same time as an attack of pleurisy; that it coincided in position with the pleural adhesion; that it appeared roentgenoscopically to be on the surface of the lung and not within it; and that its remains were visible on the surface of the collapsed lung. It was not a cavity because it had formed too rapidly, did not show decreased density in the center, did not appear to be in the substance of the lung and was hardly visible in oblique positions, gave no stethoscopic signs of cavitation, and retained its circular outline instead of falling in when the lung was collapsed.

KNOX, ROBERT. Cranial radiography. (2) The sphenoidal sinuses. *Brit. J. Radiol.*, (*B.A. R.P. Section*), March, 1924, xxix, 92–102.

The sphenoidal sinuses are probably the most difficult region of the skull to examine satisfactorily. The anatomical position of the sphenoidal bone contributes largely to the difficulty, while the bony relations of the sinuses and the impossibility of projecting a shadow which will be quite clear of that of the denser structures increases the difficulty. The best position is the lateral taken in nearly the same position as for the sella turcica. The roentgenographic base line passes on the outside of the skull along the level of the lower boundary of the sinus. Hence if the base line be taken and a point marked in front of the middle perpendicular line about 1.5 inches forward from that line the direct lateral view of the sinus will be obtained. Stereoscopic negatives are of great value for the examination.

On account of the central position in the skull and the large air spaces, it is possible to project the sphenoidal sinuses in any aspect on the negative in the posteroanterior position; but even when the best quality of negative is obtained, the diagnostic value of a roentgenogram in the posteroanterior position is not very great.

There is a third position which allows the production of fairly good diagnostic negatives. This is the one in which the film is placed below the chin and the central ray is projected from above downward and forward. If the patient is instructed to place the head as far forward as possible it should be easy to get the chin nearly to the center of a 10 × 12 plate. The angle at which the central ray is set determines the position of projection of the sphenoidal sinuses upon the negative. This procedure produces an excellent view of the base of the skull. A modification of this method makes use of a small film molded to the roof of the mouth. In the latter case the shadow of the lower jaw is eliminated.

In the roentgenogram, these sinuses will be seen to vary in size considerably. They appear as clear, irregularly shaped shadows in front of and frequently almost surrounding the anterior part of the sella turcica. The shape is very irregular and on this account it is often difficult to detect injuries in the region. The chief diagnostic difficulty is to determine the presence of fluids in the sinuses. A slight increase in the opacity may indicate a thickening of the lining membrane, while a considerable density indicates a considerable quantity of fluid.

LAFFERTY, ROBERT H., and PHILLIPS, C. C. Roentgen diagnosis in urology. *Southern M. J.*, August, 1924, xvii, 623–626.

The roentgenoscope has very limited use in urology, the greatest utility being found in roentgenographic methods. By use of the Bucky-Potter diaphragm and an opaque catheter in the ureter, more than 96 per cent of the calculi in the urinary tract can be discovered.

Anomalies in the urinary system occur rather frequently. In a recent analysis of 500 cases, 7 anomalies or 1.4 per cent were discovered.

Because of pain symptoms resulting from use of opaque solutions like sodium bromide solutions in visualizing the urinary tract, preference is given to injections of oxygen by means of Bayeux's oxygenateur. The oxygen is injected to a pressure of 50 cm. of water or about 38.5 mm. mercury and is quickly expelled or absorbed causing practically no subsequent pain and no damage to the kidney.

LAU, FREDERICK T. Recurrent calculi in the urinary tract. *J. Am. M. Ass.*, Jan. 24, 1925, lxxxiv, 272–278.

In the urologic clinic of the New York Hospital since its establishment in December, 1920, the following cases of calculi in the urinary tract have been admitted: neck 39; ureter 18; bladder 19; prostate 3; and urethra 1. Subsequent examinations made on 28 out of the 57 patients with kidney or ureteral calculi showed definite recurrences in 3 cases. One of these patients showed calculi eight months after primary operation, and no stone to date four months following secondary operation. Another patient showed calculi after a second operation. The last two patients gave negative roentgen-ray findings following each operation. The composition of these recurrent stones was mainly phosphates of ammonium, magnesium and calcium with a small amount of calcium carbonate. These cases are reported in detail. In 2 of them, nephrectomy had been done previous to their admission in this clinic, one for calculi and one for hydronephrosis; and in both of these cases large calculi remaining in the kidney leave cause for speculation as to the possibility of at least partial restoration of function in the sacrificed kidney.

Postoperative roentgenographic examination should be made as a routine before the patient is discharged and at definite intervals thereafter. Operative technique should include precautions against sutures acting as points of deposit for urinary salts, as well as all known methods to guard against left-over calculi. The chemical composition of all removed calculi should be studied with the object in view of correcting faulty metabolism and urine reaction.

LENK, ROBERT. Roentgen investigations on the question of the fluctuation of inflammatory pleural effusions. *Wien. klin. Wchnschr.*, Nov. 20, 1924, xxxvii, 1206–1208.

The general opinion, based upon percussion methods, seems to be that inflammatory exudates in the pleura are more or less immobile, probably because of early formation of adhesions. The author shows that roentgen observations are in complete disagreement with such a view. The results of examinations on a total of 19 cases, 10 of tuberculosis, 7 pleuritis, and 2 pleural metastases, are summarized, and brief reports are made on 8 cases. It was found that only 2 of the cases showed complete immobility of the pleural effusion, but it is pointed out that if observation had been delayed for ten or twenty minutes instead of the few minutes it took to change the position of the patient from the erect to the supine, the fluid might have been given a chance to reach the apical regions of the thorax. In the remainder of the cases, change of posture resulted in an intense darkening of the previously light upper lung areas in 11 cases, to slighter but still distinct clouding in 3 more cases, and to an uneven clouding and a considerable change in the shape of the exudate in the remaining 3. The character of the exudate was confirmed in all cases by puncture.

It may therefore be stated that contrary to prevailing teachings, inflammatory pleural effusions in most cases are mobile upon change of posture, promptly and more or less completely. This occurs equally in fresh or old exudates or in acute inflammatory, tuberculous, carcinomatous exudates of small or great extent.

LERI, ANDRE, AND COTTENOT, PAUL. Syphilitic epilepsy revealed by the roentgenogram: osteitis of the internal face of the skull (three observations). *Bull. Soc. franç. de dermat. et syph., Par.*, 1924, No. 5, 242–250.

Epilepsy is frequently of syphilitic origin and may be relieved and cured by antisyphilitic treatment. Often this condition may be due to syphilis, even though there are no other symptoms present, and the Wassermann reaction is negative. In such cases, the roentgenogram is the only known means of diagnosis. By means of profile roentgenograms of the skull, the writers were able to recognize three varieties of syphilitic osteitis in 3 different cases, namely, gummatous nodule, osseous ulceration and hyperostosis. The following case reports are given: a young girl, aged nineteen, had suffered from epilepsy for three or four years, attacks becoming quite frequent, as often as 2 or 3 each week. The left leg was first affected, then the right leg, and then the left arm. The symptoms were typical of Jacksonian epilepsy. There were no symptoms of syphilis; the Wassermann reaction was also negative. The family history was not definitely indicative of syphilis, although the mother had suffered several miscarriages. A roentgeno-

gram of the skull showed, immediately to the right of the median line, a nodule the size of a small hazelnut. This was in the region corresponding to the cortical center affecting the left lower limb. On this diagnosis, antisyphilitic treatment with bismuth was instituted. The attacks ceased immediately and completely, with the exception of a very slight attack on the fifteenth day after the treatment. A comparison of the roentgenograms before treatment and four months after treatment is most convincing; the gummatous nodule had completely disappeared during this time.

The second case is that of a woman thirty-nine years old, whose symptoms consisted mostly of defective hearing and sight. Examination disclosed paresis of the right external ocular motor nerve and an hemiasynergia of the right upper and lower limbs. The patient had two children, both born normally; there were no symptoms of syphilis; and the Wassermann reaction was negative. The lesion observed, by means of the roentgenogram, in the region of the pons-cerebellum was evidently a syphilitic gumma, for on giving antisyphilitic treatment (bismuth) it disappeared completely, as shown by subsequent roentgenogram. Before treatment, the roentgenogram showed a large irregular undulation of osseous ulceration; after treatment, this had disappeared entirely.

The third case is that of a patient thirty-four years old who, since the age of twelve, had suffered from epileptic attacks, with the exception of the period between sixteen and twenty-five years. There were no indications of syphilis. Roentgenogram showed in the frontal region a large growth of bony tissue 5 to 6 cm. long, and 1.5 cm. thick. The patient did not respond to antisyphilitic treatment, but the writers consider the condition to be due to congenital, or possibly hereditary syphilis. The lesion noted is a typical case of hyperostosis. Further treatments are to be continued.

It is proved, then, that osseous lesions shown in the roentgenograms of the first 2 cases were of syphilitic origin, and that relief from the epilepsy could not have been obtained without antisyphilitic treatment.

LEURET, E., AND DELMAS-MARSALET, P. Respective values of the manometric and roentgenologic data in artificial pneumothorax. *Rev. de la tuberculose, Par.*, 1924, 3. s., v, 332–365.

Diagnosis of pneumothorax is best accomplished by collaboration of three methods, clinical examination, the roentgenogram and a study of the intrapleural pressure. By a combination of these three methods of examining the lungs, a more complete and precise understanding of the conditions present can be obtained. Experiments were carried out with artificial pneumothorax and a comparison of the efficiency of these three methods of diagnosis made. The present paper is concerned mostly with a method of measuring the intrapleural pressure and the working out of insufflation curves to determine their value in the study of pneumothorax. It was found that, although no specific information is added to this subject by a study of this new method, there is offered a means of investigation of the pleura and lungs which merits use along with the clinical and roentgenologic examinations. No detailed description is given of the roentgenologic methods, mention only being made of the efficiency with which the roentgenogram will detect air spaces in the lungs in cases of pneumothorax, and the value of this means of substantiating the clinical diagnosis.

LEWALD, LEON T. Complete transposition of the viscera. *J. Am. M. Ass.*, Jan. 24, 1925, lxxxiv, 261–268.

Complete transposition of the viscera is less of a rarity than is usually believed. The author observed the following frequency: One case in 5,000 necropsies; one case in 35,000 physical examinations of U. S. Army recruits; and 29 cases in about 40,000 roentgen-ray examinations of the chest and the digestive tract. The latter frequency, however, is somewhat exaggerated since many of the cases were sent for roentgen-ray study when the transposition was already known to be present. The data on the 29 cases recognized roentgenographically are summarized in a table. The transposition was usually complete including all the thoracic and abdominal viscera and the kidney and suprarenal glands.

There are two types of congenital dextrocardia; (1) that occurring in general transposition, and (2) that not associated with transposition. The position of the aorta in the first type is to the right of the median line, while in the second type the aorta remains in its normal position. In the second type one would not expect to find the mediastinal shadows so completely reversed in the region of the aortic arch nor the apex so sharply outlined as in cases of dextrocardia associated with complete transposition of the viscera.

Retraction of the heart to the right side is not unusual. It may be so complete that none of the heart shadow can be made out to the left of the median line. Moreover, one can usually make out some roentgenographic evidence of fibrosis of the right lung and pleura which leads to the assumption that

pleuropericardial adhesions, together with contraction of the fibrous tissue in the lung causes retraction of the heart to the right. When roentgenographic evidence of fibrosis is lacking and there is no transposition of other viscera the condition is to be regarded as the rotation type of dextrocardia. Displacement of the heart to the right from pressure on the left side has been observed often. The most common cause is a large amount of fluid in the left pleural cavity which is easily recognized roentgenologically. Other causes are artificial pneumothorax, tumor, hernia or eventration of the diaphragm.

Non-rotation of the colon is quite different from transposition of the viscera. It may, however, be associated with it, in which case the appendix will be found on the right side. Nine cases of non-rotation of the colon have been observed in about 40,000 examinations of the abdomen. No examination of the digestive tract should be terminated until the location of the cecum at least has been determined. Cecum mobile is due to excessive descent of the cecum and is frequently incorrectly diagnosed as chronic appendicitis. A combination of two or more of these conditions may be present in one individual. For example, failure of the colon to rotate in a person with complete transposition of the viscera will leave the appendix on the right side while the heart and stomach are also on the right.

LeWald, Leon T. Right-sided diverticulitis and diverticulosis. *Radiology*, January, 1925, iv, 43–48.

The term diverticulitis should be used only when there is a complicating inflammation, and diverticulosis should be used to denote the presence of diverticula unassociated with inflammation. The two conditions may occur in one individual as illustrated by a case described. Diverticulitis may also be encountered ordinarily on the right side of the abdomen as well as the left. One of the striking roentgen evidences is the presence of a localized narrowed lumen with spasticity, indicative of surrounding pressure such as might be caused by an inflammatory exudate. If the opaque injection be given prior to the meal this narrowing may be the only indication of diverticulitis because diverticula were found more frequently after an opaque meal than after an injection. The tendency for prolonged retention in a diverticulum of the digestive tract is of value in the differential diagnosis from ulcer.

It is noteworthy that the presence of diverticula has been observed in different regions of the digestive tract of the same individual in a number of instances. The clinical symptoms of subacute diverticulitis associated with an inflammatory mass may be confused with those of carcinoma of the colon. Such a case is described. A distinct mass could be made out in the descending colon in the region where a diverticulum had been noted at the preceding roentgen examination. There was no tenderness in the region of the appendix. The roentgen examination at this time showed evidence of spasm and incomplete filling of the ascending colon in the region of the palpable mass. This appearance was against a diagnosis of new growth and a third examination a month later showed disappearance of the palpable mass. This was evidently a case of right-sided diverticulitis. Two similar cases, but left-sided, are described.

MacRae, John D. The general aspect of tuberculosis as presented by *x*-rays. *Radiology*, December, 1924, iii, 464–466.

The interpretation of roentgen-ray films of lungs is to be improved by conferences of roentgenologists with clinicians and by frequent post-mortem studies. The roentgenographic findings and those of the internist must always be considered together.

It is rare, if ever, that a tuberculous lesion is found at the base of the lung, unless there is evidence of a lesion old or recent in one or the other apex. One of the most difficult problems in interpretation is the evaluation of changes in the lung roots. In children, for instance, it is absolutely necessary to determine all clinical factors in making the diagnosis. Capped trunks represent the arrested processes which occurred in childhood and which are seen quite often in adults. In adults, hilum tuberculosis has generally been secondary to bone or abdominal tuberculosis. Hodgkin's disease and lymphosarcoma may simulate it.

Caseous tuberculous pleurisy is now and then recognized roentgenologically. The patients are usually adults who had not been exposed to tuberculous infection in childhood.

Meyerding, Henry W. Roentgenographic types of sarcoma of the long bones. *Radiology*, December, 1924, iii, 457–463.

The most characteristic type of long bone sarcoma roentgenographically is the spindle shaped swelling appearing in the diaphysis and apparently pushing out the periosteum by tumor growth. There are fine lines of bone radiating out in the substance of the tumor. This type is easily recognized, and benign growths rarely simulate it. In this type irregular masses of bone may appear beyond the cortex without the sun-ray appearance; the shaft then appears clear or slightly irregular, and although the medulla does not seem to be

affected, examination of the specimen in the late stages will show that it is.

Another characteristic type is the sclerosing, which presents a central mass of increased density at the end of the shaft, usually involving the epiphyses and sometimes invading periosseous structures with dense, irregular bone masses. The entire bone is involved so that the roentgenogram shows no difference between cortex and medulla. There is also a periosteal type apparently not involving the cortex but causing pressure absorption. In the case described the tumor appears to involve only one side of the bone, the body of the tumor appearing as a rarefied mass (round cell sarcoma). In a somewhat similar type, the tumor may surround the shaft and invade the periosseous tissue.

The central sarcomas appear to perforate the cortex at times and produce large tumors slightly resembling osteochondrofibromas. Central tumors may resemble cysts or appear sclerosed. There is also a group characterized by rapid destruction of bone in all directions, with perforation and invasion.

Occasionally the roentgenogram of sarcoma presents the picture of destructive arthritis, probably owing to extension through the capsule of the periosteal tumor. In postoperative roentgenograms, sarcoma may simulate osteomyelitis with sequestra, especially when infected.

These most common types of sarcoma are illustrated by brief case reports and illustrations.

MILLER, A. F., AND HAMON, H. T. Some lessons learned from comparison of chest roentgenograms and physical findings in twelve hundred cases covering four years' experience with tuberculous ex-service men. *Tubercle, Lond.*, September, 1924, v, 586–594.

In the final analysis it must be left to the experience and skill of the physician to combine the roentgen-ray and physical findings in the diagnosis of doubtful or difficult pulmonary cases.

Of the 1200 cases included in the present study of patients admitted to the Nova Scotia Sanatorium, the pulmonary condition on admission was as follows: (1) non-tuberculous, 332 or 27.7 per cent; (2) suspected tuberculosis, 42 or 3.5 per cent; (3) positive tuberculosis, 826 or 68.8 per cent. The use of stereoscopic chest roentgenograms and more careful laboratory analysis of the sputum and of the blood have brought about refinements in diagnosis and cast doubt on the old accepted criteria of positive tuberculosis. Thus, tuberculous disease could be discovered in only 551 out of 819 patients giving the suggestive history of cough, expectoration, pains in the chest, loss of weight, strength, appetite, shortness of breath and sweats. Even a history of hemoptysis frequently fails, because of 238 cases of hemoptysis in this series the roentgen ray showed definite parenchymatous changes in only 168 or 70 per cent.

Checking up on roentgen plates has taught that slight dullness even in the apices does not necessarily indicate tuberculous disease or even respiratory disease. Among the cases giving real difficulty in reaching a diagnosis were many in which the clinical findings were uncertain or negative and the roentgen shadows in some showed thickened or infiltrated paravertebral trunks leading to the apices, in others minute nodal parenchymatous changes at the summit of the lung. Later studies, clinical and roentgenological extending over a number of years showed that a good many of these cases had actually not been tuberculous from the very beginning. That is, not every roentgen-ray picture showing thickened peribronchial trunks or minute opacities at the apex indicates clinical disease requiring treatment.

Increased fibrotic thickening of the hilus shadows accompanied by calcified nodes is of little clinical importance. However, when there is marked evidence of old infection with more than usual evidence of old focal infection in the surrounding parenchyma prolonged observation is necessary before clinical disease can be ruled out. It has been impossible to establish from among the present series of patients any definite roentgen-ray picture characteristic of the average non-tuberculous bronchitic condition that could be accepted as basis of diagnosis.

In 29 cases giving history of gas poisoning the meager roentgen-ray findings were disappointing. In severe gassing, a definite increase of lung markings has been noted, but in those giving a history of slight gas exposure the roentgen-ray picture has been the same as that of the normal chest or at the most of a bronchitic condition. Tuberculosis as a result of gas poisoning occurred in only one of these 29 cases.

A diagnosis of activity may fairly readily be made from the "fluffy" bronchopneumonic areas generally seen roentgenographically in these cases. In stationary chronic cases it is practically impossible to differentiate between active and non-active cases even when serial plates are taken; but in chronic slightly progressive cases usually afebrile, the roentgen ray has been of great value as serial plates may demonstrate the invasion of new fields before there is any clinical evidence of spread.

Conversely, in retrogressive cases the roentgen ray has been most helpful in determining clearing and organization and in showing fibrotic changes.

MORRISON, L. B. Diaphragmatic hernia of fundus of stomach through the esophageal hiatus. *J. Am. M. Ass.*, Jan. 17, 1925, lxxxiv, 161–163.

The author has observed a total of 42 such cases in about 3500 stomach examinations. The small hernia is very difficult to discover in the roentgenogram. For the study of these cases the roentgenoscope is the method of choice. The patients varied in age from six to seventy-six years, females predominating.

The roentgen-ray examination is first made with the patient upright and viewed anteroposteriorly and obliquely. Note is taken of the position of the diaphragm and its movements, the cardiac shadow and the posterior mediastinum. A gas bubble, if present, may best be seen while looking obliquely through the posterior mediastinum. A barium meal is then given. As a result of a normal sphincter-like effect at the cardia, a column of fluid 2 or 3 inches high is seen in the lower esophagus when the barium is rapidly ingested. In nearly all hernia cases the fluid column is from 4 to 5 inches high and the esophagus appears a trifle enlarged. The filled hernia will often partially block the esophagus. After the barium meal is ingested, an attempt to fill the hernia by pressure is only occasionally successful.

The patient is then placed horizontally, face up and further observed. The cardio-esophageal opening was found patent in all the patients in this series, a finding which is unusual in the normal stomach. As the fundus fills with the patient supine, instead of rounding up under the diaphragm away from the esophageal opening, it tends to surround the esophagus high up posteriorly and to the left, pointing into the esophageal hiatus. This is observed also when the hiatus is large without a hernia.

The patient is then rotated into the left oblique position and made to take a full inspiration. This usually fills the hernia. At times other positions give better results. Often the hernia cannot be filled on the first observation but fills quite readily the following day. The fundus seems to lift up from the diaphragm somewhat to the left posteriorly, and as it comes through the hiatus it partially surrounds the esophagus filling first the lower part of the posterior mediastinum and then pushing out beyond the heart shadow. When the fundus is herniated and filled it causes pressure and prevents the passage of food down the esophagus. The discomfort from the hernia depends not on its size but on its being adherent or on its blocking the esophagus.

The roentgenologist can help determine the type of treatment by carefully determining the size of the hernia, the symptoms when the sac is filled and the amount of dilatation of the esophagus. He can also suggest the site of operation. A brief description is given of a few representative cases.

OTTOSEN, DAVID. The roentgen-diagnosis of diaphragmatical hernia and eventration. *Acta radiol., Stockholm*, Dec. 31, 1924, iii, 509–512.

Roentgenoscopic examination of a patient with hernia shows paradoxical movement of the diaphragm on both sides, while the line forming the upper boundary of the air filled space in the stomach hardly moves during respiration. In addition, the hernial ring is visible, especially when the patient is examined by lateral view. On the other hand, in eventration the movement of the diaphragm during respiration is normal and hernial ring is absent in the various positions assumed by the patient during examination. Positions of most importance in establishing the diagnosis are the side to side view in vertical or horizontal. One case is illustrated roentgenographically.

PEIPER, HERBERT, AND KLOSE, HEINRICH. The roentgenographic demonstration of the spinal cord (myelography). *Klin. Wchnschr.*, Dec. 2, 1924, iii, 2227–2231.

Use was made of Merck's iodipin (20 to 40 per cent) instead of lipiodol which was unavailable. The results reported on were observed in 14 cases. The iodipin was injected in 2 c.c. quantities in all cases far up above the suspected spinal tumor, that is suboccipitally; and only in deep caudal tumors was the injection made between the twelfth thoracic and first lumbar vertebrae. An injection made much lower may lead to false conclusions. All test spinal punctures must be omitted for the day preceding the myelography. The injected iodipin must be free of all air bubbles and the injection is made slowly under light, uniform pressure. The continuity of the stream of iodipin should be maintained if possible. Anesthesia is not necessary but may be found useful. After injection the patient is made to cough or his spine is tapped in order to prevent a fixation of the oil, and after four to five minutes the first roentgen exposure is made. The intestinal canal must be clear, and the patient placed upon a 30° inclined plane with the head up. A Bucky diaphragm and compression is employed. An exposure of 15 seconds is made using the Goetze tube; and excellent

pictures are obtained revealing even the smallest drop of injected material. The films used were coated with emulsion on both sides.

At the first sitting a search is made over the whole extent of the vertebral column. On the second day the patient is examined again with similar roentgen technique. A comparison of the first and second roentgenograms is necessary before a conclusion can be formed.

It has been shown that every spinal cord compression that has progressed to the extent of producing neurological symptoms appears to be sufficiently big to cause permanent retention of iodipin, that is, the oil is arrested in its settling out process to the bottom of the spinal canal. A temporary arrest of the oil indicates nothing demonstrably pathological. Adhesions as well as tumors may be responsible for complete or partial arrest of the oil. In general experience up to the present shows that the lower iodipin silhouette is more characteristic for extra- and intradural tumors than for closure caused by adhesions or spinal compressions.

Of importance in the diagnosis of deep-lying caudal tumors is the lower contour of the iodipin which in one such case was found to be strikingly gnawed out and distinctly different from the normal caudal picture.

Iodipin may also be employed in the differential diagnosis of fractures of the spine with spinal cord symptoms in order to determine the location of the compressing splinter.

It may be stated tentatively that a positive Sicard sign (i.e., arrest of oil in the spinal canal) under proper technique appears generally to indicate tumor, compression or adhesion. The neurologic and other symptoms in the individual case will determine which of the above three is the correct diagnosis. A negative finding has always justified a conclusion against the diagnosis of the compression. The neurologic diagnosis is under all circumstances the guide as to whether myelography shall be performed or not.

In performing myelography it is recommended that only the new Merck preparation be employed because of its minimal irritative action. A special warning is uttered against the application of this technique by those unpracticed in it. It is not for the general practitioner because of the great danger involved. Moreover the indication for performing myelography is contingent upon the advice of the neurologist.

REGAN, JOSEPH C. Massive collapse of the lung in acute poliomyelitis. *Lancet, Lond.*, Dec. 13, 1924, ii, 1222–1224.

A report is given of a case occurring in a child ten months old suffering from acute poliomyelitis. The massive collapse occurred in the lower lobes of the lungs involving first predominantly one side and later the other. Atelectasis in poliomyelitis is very rare, and it could not have been produced by any of the commonly recognized causes of the condition. Two possible explanations are considered: (1) the compression of the bases of the lungs by a paretic but overactive diaphragm which kept pace with the dyspneic respiration which was so peculiar to the case; and (2) the paralysis of the broncho-dilator fibers or the overactivity of the broncho-constrictor fibers of the vago-spinal nerves, in either case leading to constrictor action and collapse of the dependent lung. The latter effect was probably operative in the present case owing to the concomitant existence of a cardio-respiratory syndrome of bulbar origin.

RENANDER, AXEL. Two cases of typical osteochondropathy of the medial sesamoid bone of the first metatarsal. *Acta radiol., Stockholm*, Dec. 31, 1924, iii, 521–527.

This condition has apparently not been described before. The first case occurred in a boy aged thirteen. There was trouble only from the left foot, although the roentgen picture showed the same changes in the right. The medial sesamoid bone underneath the head of the first metatarsal was seen roentgenographically to be deformed, considerably flattened in the dorso-plantar direction and also slightly from side to side. The outlines of the bone were uneven and notched in fine waves. The normal bone structure was replaced by spots of increased density and in the dorso-plantar view the bone seemed, as it were, to be divided into three unequal fragments.

The second case occurred in a woman, aged thirty-six. Here all the typical changes existed in the sesamoid bone of the right foot only, the corresponding bone in the left foot showing changes that may be regarded as a transitional change preceding bipartition of the sesamoid. The roentgenographic picture and the microscopic changes observed (in the second case) together with the clinical symptoms indicate that these cases belong to the group of osteochondropathies associated with the names of Köhler, Perthes, Schlatter, etc.

SANTE, L. R. Study of miliary tuberculosis by serial radiographic examination. *Radiology*, December, 1924, iii, 467–471.

A report is given based on roentgenographic study of 15 cases of miliary tuberculosis studied during the past five years. In the generalized type of the disease, where all the organs are involved, the lungs are seen studded with

minute infiltrations uniformly distributed in the apex and base. Miliary tuberculosis cannot be visualized roentgenographically, but the conglomerate tubercles which are soon formed are readily recognized and are the lesions which give rise to the characteristic roentgenographic picture. Serial roentgenograms taken at intervals during the course of the disease reveal at first only minute infiltrations here and there in the lung field. These increase in number and rapidly become larger but they never attain the size of the infiltrations found in bronchopneumonia, and they rarely become confluent.

Where the localized form is of the pulmonary type, the lesion is likewise readily recognized, but where the peritoneal or meningeal types occur, the diagnosis is impossible from the roentgenogram. Under these conditions the chest film shows no evidence of abnormality, yet the patient may be suffering with miliary tuberculosis, autopsy revealing advanced involvement of either the peritoneal or meningeal type without a single demonstrable lesion in the lung. In one case, miliary tuberculosis was observed to follow the rapid absorption of a pleural exudate. Every roentgenologist has encountered instances in which numerous minute, shot-like, calcareous deposits are seen in the lungs. Their symmetrical and generalized distribution suggests that they may be due to healed lesions of miliary tuberculosis. The condition does not represent any active disease because serial roentgenograms show no change in the calcareous deposits for long periods.

Sergent, Émile, Durand, Henri, and Cottenot, Paul. Large adenopathies in tuberculosis of the adult. "Gangliopulmonary" tuberculosis of the "young adult." *Rev. de la tuberculose, Par.*, Oct. 1924, 3. s., v, 593–605.

In the diagnosis of tracheobronchial adenopathy, the use of the roentgenogram has been adversely criticized by certain workers. The writers are of the opinion, however, that when the proper care is exercised, such diagnosis will be greatly aided by use of the roentgenogram, and they offer case reports to show to what degree their use might be justified. In the first place, tracheobronchial adenopathy has been generally considered a condition found only in children, and that it seldom, if ever, occurs in the adult. Sergent and Combier, in 1906, called attention to the fact that this is very often found in adults, and this was amply confirmed during the period following the recent war. It is true that in children in primary infection with the tubercle bacillus, enlargement of the lymphatic glands is quite common. In the adult, on the other hand, this enlargement of the lymphatic glands is not so often noted because tuberculosis at this stage is usually the result of reinfection, and primary infection is rare. In the "young adult" (from about 16 to 22 years of age), however, the accompanying reaction in the lymphatic glands in the region of the lungs is quite common and easily demonstrated.

In the cases reported, the subjects being young adults, the clinical and roentgenologic diagnoses were in perfect harmony, and left no doubt as to the nature of the affection, nor of the location of the predominating lesions. In two cases, the autopsy confirmed the diagnosis made by the two methods. The first case is that of a man whose family history was good, and who himself had had no respiratory affection until December, 1921, when he suffered an attack of pleurisy. This was followed by rapid loss of weight, dyspnea, dry cough, etc. There was no hemoptysis and the temperature ranged between 37° to 38.3°C. The clinical symptoms were those of large tuberculous adenopathy on the left side. The roentgenogram confirmed the diagnosis. The patient died June 10. Autopsy showed a large mass in the mediastinal region formed by large lymphatic glands, some caseous, dry and hard, and others soft. The right lung was congested, but without visible granulations. The left lung was penetrated by masses of enlarged lymphatic glands. This type of "gangliopulmonary" tuberculosis does not always show symptoms of tuberculosis, but by means of roentgenograms the diagnosis is facilitated. In the other case in which the patient died, autopsy confirmed the diagnosis made by means of the roentgenogram. In the third case, the patient showed loss of appetite and general fatigue, but no expectoration, nor cough, nor hemoptysis. The general state was satisfactory and the temperature remained at 37°C. The tubercle bacillus, however, was found in the feces. The roentgenogram showed large opacity in the right lung, which was typical of tuberculous lymphatic glands. The patient was discharged in about three weeks. The other cases reported showed similar histories. It seems, then, that adenopathies in the adult affected with primary tuberculosis is not uncommon, and may be readily detected by means of the roentgenogram.

Sinding-Larsen, Chr. M. F. Spotted posttraumatic atrophy of the bones of the knee-joint. *Acta radiol., Stockholm*, Dec. 31, 1924, iii, 515–520.

The patient, a man aged forty, had an affection of the knee bearing a striking clinical

resemblance to a fibrous fungus, and had received treatment for tuberculosis. The patient however, was negative to all tests for tuberculosis, and roentgenograms of the knee showed peculiar atrophic spots in the condyles and the patella.

The lower end of the femur and the upper end of the tibia presented a spotted rarefaction of the trabeculae in the center of the condyles and also diffuse sclerotic change around these rarefied areas. The upper part of the patella, especially, showed similar decalcified spots with pronounced sclerotic changes surrounding them. The cortical osseous substance appeared to be preserved over the entire extent of the articular surfaces and the articular cartilages seemed of normal height. The case was diagnosed as chronic post-traumatic arthritis with spotted bone atrophy. Treatment by massage and diathermy resulted in complete recovery clinically as well as roentgenologically.

The roentgenological description was made by Gösta Forssell.

SOUTHGATE, H. W. A case of osteitis fibrosa. *Lancet, Lond.*, Dec. 6, 1924, ii, 1172–1173.

Because of its relatively rare incidence a report is given of a case of osteitis fibrosa occurring in a woman aged forty. Examination at autopsy disclosed definite, irregular enlargement of the vault of the skull with haphazard calcification and absorption. The history of intermittent pains, the bone tumors and the extreme atheromatous condition of the small vessels all point to Paget's disease. The wasting condition in the ribs and other bones where the cortex was irregularly replaced by a delicate vascular fibrous tissue suggested, however, that the case might perhaps be more correctly classed as osteitis fibrosa.

SUTHERLAND, CHARLES G. A radiologic study of soft-tissue tumors. *Radiology*, November, 1924, iii, 420—424.

A summary is given of the roentgenologic characteristics of certain benign tumors. The lipomas appear as definitely circumscribed shadows with a central area of decreased density and a periphery of increased density. Both areas varied in extent and in density in individual tumors. One of the series discussed showed multiple calcareous deposits in the tumor. The fibrolipomas were less clearly demarcated from the surrounding tissues and none of them revealed the variation in density of the center and periphery. Two were homogeneous throughout and the remainder exhibited a wavy mottling due no doubt to increased connective tissue. In the fibrochondro-lipoma the shadow was similar to that of the fibrolipoma with the addition of a slight mottling due to the cartilage. The two hemangiomas varied markedly in the roentgenogram; one appeared as a small, sharply circumscribed homogeneous shadow, while the other, which was thrombosed, was not sharply circumscribed and presented a wavy mottled shadow.

The lymphangioma was seen as a thick-walled cyst overlying the muscle; in the wall were fine, radiating, horizontal lines, similar to the sun-burst rays of a periosteal sarcoma. A fibro-osteoma presented a transparent center with a periphery of increased density that had a "woven" appearance very suggestive of a bird's nest. The osteochondromas had the typical cauliflower appearance of this tumor, and the chondroma, the flat, undifferentiated shadow of the pure cartilaginous growth.

Whatever connection they may have pathologically, the roentgenograms of neurofibromatosis, epithelial hyperplasia and elephantiasis differ materially. Neurofibromatosis casts a shadow suggesting small multiple nodular areas rich in connective tissue. In the epithelial hyperplasia there is a marked increase in the density of these areas, while that of elephantiasis resembles closely the picture of lymphangioma, the horizontal striae in the capsule being more or less apparent, according to the size of the growth.

Almost without exception the malignant tumors present homogeneous shadows and the tendency to demarcation is less frequent.

UPSON, W. O. Roentgenologic findings in a case of phytobezoar. *Radiology*, January, 1925, iv, 49–51.

The term "phytobezoar" is applied to a mass found in the stomach or intestines composed of food materials such as skins and fibers of fruit, colloid portions of vegetables and starch granules with an occasional small amount of other organic material frequently surrounding fruit seeds.

A case is described in a farmer, aged forty-two, who complained of chronic gastric symptoms. The barium meal study revealed a decided thinning out of the barium in about the middle portion of the stomach. This area measured 2.5 by 3 inches in diameter and it was found on manipulation that this mass could be easly made to change its position, it being possible to move it to any desired point in the stomach from cardia to pylorus. This mass did not interfere with the normal peristalsis and there was no evidence of pyloric obstruction. At the 4.5 hour examination only a trace of barium remained in the stomach. From the roentgenologic findings a free tumor in the

stomach was diagnosed. A gastrotomy was performed and a foreign body the size of a hen's egg was found free in the stomach. The patient made an uneventful recovery. The foreign body removed was oval in shape and measured about two inches in its greatest diameter. It was black on the outside and brown throughout a section. In places there were scale-like layers that looked like fruit slices. Microscopically the mass consisted principally of cellulose in layers and in the very center there was found a persimmon seed.

ROENTGEN AND RADIUM THERAPY

BEHNE, KURT F. Mammary carcinoma and its timely roentgen therapeutic and surgical treatment. *Klin. Wchnschr.*, Nov. 11, 1924, iii, 2101.

Preoperative radiation of mammary carcinoma is as yet not completely grounded scientifically and is more or less a matter of current discussion. Whether an operable mammary carcinoma belonging to the first Steinthal group may safely be left to exclusive radiation therapy is also an unsettled question at present.

Exception is taken to the viewpoint expressed by Jarre that there exists a cancer immunization effect for a period lasting 10 days after an irradiation of a mammary cancer. There seems to be no scientific foundation for this statement. Moreover, his assumption that the reaction to radiation in the affected area has completely subsided after twelve weeks is erroneous. Pulmonary complications as a result of the irradiation of a mammary carcinoma are great rarities in the practice of experienced and careful roentgen therapists.

CASE, JAMES T. Radiation therapy of malignant disease. *J. Am. M. Ass.*, Jan. 10, 1925, lxxxiv, 108–114.

After a general discussion of the problem, it is pointed out that the limitations of surgery in the treatment of cancer are: (1) possibility for recurrences or metastases to develop; (2) once the operation is completed the rôle of the surgeon is finished and he is nearly helpless against further eventualities, and (3) he is helpless in the advanced cases to a great extent. Radiation therapy counteracts these deficiencies to some extent. It has a direct effect upon the tumor; it acts on the depth as well as the surface and exercises a selective action on malignant cells. In combination with surgery, preoperative and postoperative radiation therapy offers one of the best guarantees now possible against recurrence if metastasis has not already occurred.

DAVID, O. Roentgen therapy in internal medicine. *Therap. d. Gegenw.*, 1924, lxv, 315–319; 362–366.

A survey of the applications of roentgen therapy in internal medicine as revealed in the recent literature, discloses a range of applications of extraordinary possibilities. The whole field is one of the most difficult and at the same time very stimulating. The difficulty lies in the fact that successful therapy is possible only by rather strict adherence to careful internal diagnosis; and the latter should be the constant guide to roentgen therapy. The field is a stimulating one because it yields successful results provided quality and quantity of the radiation are gauged by the internal findings in the individual case. Although the more spectacular attack upon large tumors with massive doses of roentgen rays is impressive to the lay mind, it will be recognized by anyone who considers the nature of the matter more deeply that for the finer and individual therapy the future of roentgen therapy will be found to lie in the applications to internal medicine.

ELIASCHEEF, OLGA. Ulcerous roentgenodermatitis and spinocellular epithelioma on lupus erythematosus. *Bull. Soc. franç. de dermat. et syph., Par.*, July, 1924, No. 7, R.S., 75–78.

A case is reported of lupus erythematosus of the face which was treated with the roentgen ray for years, during which time the condition was not alleviated, but was further complicated by ulcerous lesions caused by the roentgen ray and a spinocellular epithelioma. The patient, a man, aged forty-seven, was in good health otherwise. The lupus erythematosus appeared in 1898 on his right ear as a very small lesion. In two years' time, this had become quite large and had spread to the side of his face. In 1903, the right side of his face was treated with the roentgen ray in one series of 8, 15 and 20 days, repeated, after 4 to 6 weeks by a second series of applications. These treatments were prolonged for thirteen years without appreciable result. Between the years 1915 to 1918, the patient lost, without pain, all his teeth; this he attributed to the destructive effects of the roentgen-ray treatments. In 1918, an ulceration began around the right ear; this was removed by surgical operation, followed by apparent cure. An ulceration then appeared on the lobe and persisted in spite of various treatments; the entire external ear became involved and was finally entirely destroyed. The epithelioma was again removed by operation, but six months later it reappeared. Because of the difficulty of further surgical operation, the

esions were treated for seven months with carbon dioxide snow with good results; in fact, apparent cure. In 1923, the lesions began to spread and became actively ulcerating. Resort was again had to roentgen radiation, which was applied for four weeks with apparent benefit. The condition was not entirely healed, but at least metastasis was prevented. Atrophy of the skin after cure of lupus erythematosus may predispose to the development of an epithelioma, and this does not respond well to roentgen-ray treatment.

GANZONI, MAURICE. A case of spinocellular epithelioma treated and cured by a single application of the roentgen ray. *Ann. de dermat. et sypb., Par.*, 1924, 6. s., v, 85–88.

Many authors have considered the spinocellular epithelioma just as subject to cure by means of the roentgen ray as the basal cell epithelioma. A case is reported in which such treatment was quickly followed by complete cure. A woman sixty-five years old was first seen Oct. 16, 1922, suffering from a large ulcerated tumor on the left temple. The tumor was 4 to 5 cm. in circumference, 1 to 1.5 cm. thick, and was of cartilaginous consistency. The first indication of the beginning of the tumor was noticed 3½ years previously, when it started as a small warty projection; it later ulcerated. Tissue section showed the presence of cells typical of spinocellular epithelioma. On Oct. 18, 1923, a single treatment with roentgen ray was carried out as follows: 75 to 80 X filtered through 4 mm. of aluminum; the apparatus of Siemens, with Coolidge tube was used; application was for 50 min. at a distance of 25 cm. The intensity of the current was 2.5 ma. After this one treatment, the tumor disappeared completely, by January the healing process having been complete.

GUDZENT, F. The action of small gamma ray doses (radium and mesothorium) on thyreotoxicoses and Basedow's disease. *Klin. Wcbnscbr.*, Dec. 16, 1924, iii, 2329–2331.

Comparatively small and definitely harmless doses of gamma rays can be used successfully in the treatment of thyreotoxicoses and Basedow's disease. There is no danger for the patient and hardly any interference with his occupation. Possibly the cases that should be excluded from this sort of treatment are those having compression symptoms of the trachea due to large thyroids. In the first place, such cases present a danger of choking because of the reactive swelling of the thyroid following irradiation, and secondly, decrease in size of the thyroid is not fully accomplished because of connective tissue alterations.

The technique employed is as follows: Radium or mesothorium tubes the equivalent of 25 mgm. radium element, filtered through 1.5 mm. brass are fixed upon cork blocks 2 to 3 cm. long and exactly 1 cm. thick. This arrangement filters out practically all the beta radiation. Four to 6 such blocks are placed on the thyroid region, fixed with a bandage and allowed to act for about fourteen hours. The maximum skin dose under such conditions is about one-fourth to one-third of an erythema dose. More recently the technique has been modified by interposing a layer of absorbent cotton 1 cm. thick (so as to increase the distance of the radium from the skin) and increasing the period of administration to twenty-four hours. In this case the dose to the gland is about the same, while the skin dose is decreased.

Mild cases require no more than a single treatment. More severe cases recover after a second treatment given two to three months later. Under certain circumstances a third treatment given after six to nine months is necessary. A total of 35 such cases has been thus treated, and brief reports of 19 of them are presented. Of the latter, 13 recovered after a single treatment; and 6 were given a second treatment. Of the latter, 2 required a third treatment.

Just how the gamma rays in such relatively small quantities exert their effect is unknown at present, but their favorable influence is undeniable.

HILL, WILLIAM. Radium therapy in cancer of the esophagus. *Brit. M. J., Lond.*, Dec. 27, 1924, No. 3339, 1196–1197.

Surgery in carcinomatous stricture of the esophagus is helpless, and treatment is reduced to palliation. Roentgen-ray therapy and the injection of various serums and chemical substances are usually disappointing. Irradiation with radium or emanation gives very much better palliative results.

An experience with a total of 77 cases yielded remarkable improvement in one-third of the cases and very substantial improvement in another third. In 3 cases the treatment was followed by fatal results within a few days of application. The treatment depends upon the extent of the cancerous growth and it is therefore very essential that exact observations and measurements be made of the nature and extent of the lesion, especially longitudinally. The whole extent of the growth as far as practicable should be irradiated. These observations refer to definitely primary malignant growths of the esophagus, all other forms being left out of consideration.

HUFSCHMITT, M. Apropos of the treatment of lichen planus by roentgenotherapy of the spinal cord. *Bull. Soc. franç. de dermat. et sypb., Par.*, July, 1924, No. 7, R.S., 71–74.

Two cases are reported in which lichen planus was cured by treating the spinal cord with roentgen rays. The first case is that of a woman fifty-two years old who had a skin eruption for six weeks and had been treated for itch several times. The lesions were typical of lichen planus, however, and when the patient came under the care of the writer, intravenous injection of neosalvarsan was first tried, but with no success, because of the intolerance exhibited. For this reason, roentgen-ray treatment was substituted. On Feb. 13 the patient received irradiations in dose of 3 H filtered through 5 mm. of aluminum. No amelioration of the symptoms resulted, so that a repetition of the treatment was carried out on Feb. 27. Six days later, the papules had subsided and complete cure of the condition rapidly followed. In the second case, the lichen planus was spread over practically the entire body. Treatment with roentgen rays was followed by complete cure, but in this case, the symptoms were at first exaggerated, and even after complete cure, the skin was left with brownish spots where the papules had been. As a result of this experience, the writer recommends roentgenotherapy in cases of generalized lichen planus, and in those cases in which the patient shows an intolerance to neosalvarsan.

KUZNITZKY, E. Filtered or unfiltered roentgen radiation in surface therapy? *Klin. Wchnschr.*, Nov. 18, 1924, iii, 2148.

In the treatment of superficial dermatoses there are, on the one hand, roentgen therapists who believe in using radiation filtered through aluminum and on the other hand, those comprising the greater number of practicing roentgenologists who still employ the old technique and apply unfiltered radiation.

The experience of ten years shows that filtration through 0.5 mm. Al does away with the harmful soft radiation and still permits the passage of a dose of radiation effective in coping with the dermatosis under treatment. Moreover, a large portion of the risk in the application of unfiltered radiation is eliminated.

MARTIN, J. M., AND MARTIN, C. L. The fractional dose method in the *x*-ray treatment of skin malignancies. *Southern M. J.*, June, 1924, xvii, 391–397.

The technique used in the therapeutic application of roentgen rays employed on superficial skin malignancies is 5 ma., 5-inch spark gap, skin target distance 10 inches, filtered through 0.5 mm. Al. This dose administered for 5 minutes is calculated to produce one skin erythema dose, and in 10 minutes two erythema doses. The exposure is repeated every other day until 4 to 6 treatments have been given directly over the lesion and nearby tissues. At the end of six days the exposed area should begin to show evidences of redness, heat and actual shrinking. If the growth is small and thin the treatment should be discontinued, but if it be thick the exposures should be continued until 8 or 10 have been given.

The accumulated effects of these exposures is to soften and disintegrate the growth. Later on healing begins at the outer margin and gradually advances toward the center. The final result in the case of cure shows the area smooth and the tissues soft and practically free from cicatrices or noticeable atrophy.

When the growth under treatment is located where there is a probability of metastases in nearby glands, higher doses are used as follows: 5 ma., 8-inch spark gap, 10-inch target skin distance, filtered through 4 mm. Al for 10 minutes. This corresponds to $\frac{40}{45}$ of an erythema dose. This dose may be repeated every three weeks with safety provided no marked degree of reaction has followed a previous exposure.

Good results have recently also been obtained by applying 6 ma. at 140 kv. peak, through 0.5 mm. Cu, 12-inch skin target distance for 60 minutes.

If a lesion can be destroyed by roentgen therapy, the authors are opposed to the removal of a section for microscopic examination, desirable as it is to know the type of growth and to have a pathologist's report. They are convinced that the use of a knife may increase the danger of metastases while cautery is too often productive of ugly scar tissue. Illustrations are given of 10 cases to show the results of treatment.

MILIAN, BELOT, J., AND NAHAN, L. A case of nevus carcinoma cured by roentgenotherapy. *Bull. Soc. franç. de dermat. et sypb., Par.*, 1924, No. 6, 318–320.

A tumor of the type of nevus carcinoma is by no means readily cured by roentgenotherapy, but, on the contrary, experience has shown this treatment to be ineffective and certainly unreliable. Because of this, the case report here given is of especial interest. A nevus tumor of the usual characteristics, and typical histologic picture, on the occipital region was found to have affected the surrounding region, the cervical and subclavicular. It was red,

circular and bled easily, but there was little pain; there was also observed a proliferation of ganglia in the surrounding area. Examination of the blood showed 4,500,000 erythrocytes, 9,200 white cells; hemoglobin 90; Wassermann reaction negative. Extirpation of some of the ganglia was first accomplished, this being followed by treatment with roentgen rays. The tumor and the ganglia were irradiated with penetrating doses as follows: 4,500 R; filtered through 0.5 mm. zinc and 2 mm. aluminum for the cervical ganglia; for the cutaneous lesions in the occipital region, 4,500 R filtered through 10 mm. of aluminum. The rays used were obtained by means of the Coolidge tube immersed in oil; a maximum tension of 200,000 volts was attained, giving a spark equivalent to 40 cm. These were continued from Oct. 31 to Nov. 17 on successive days. Following this treatment, the nodule disappeared, but the small ganglia in the left subclavicular region persisted. About a month later, the treatments were resumed to reduce the ganglia, in the cervical and left subclavicular region, the same doses as above being given, these being continued for seven days. A month later, the cure appeared to be completed. At the end of six months, there was no evidence of a return of the tumor or of the enlarged ganglia. The writers do not claim that roentgenotherapy will cure all cases of nevus carcinoma, but that in this case, persistence of treatment was successful in bringing about complete cure.

NITZESCU, I. I. The effect of ultraviolet and roentgen rays on insulin. *Klin. Wchnschr.*, Dec. 16, 1924, iii, 2343.

An insulin solution containing 1 to 2 Toronto rabbit units per c.c. was placed in a uviol glass tube and constantly shaken, the tube evacuated and exposed to the ultraviolet rays of a quartz lamp for 1, 2 and 3 hours. For the study with roentgen rays the insulin was placed in ordinary glass tubes, similarly evacuated and shaken and exposed to the rays from a Coolidge tube unfiltered, at a distance of 5 to 10 cm., for periods of 15, 30 and 60 min.

After irradiation the insulin solutions were injected into rabbits and it was found that no alteration in the hypoglycemic action had occurred as a result of irradiation either with ultraviolet or roentgen rays.

PAUTRIER, L-M. Treatment of lichen planus by medullary roentgenotherapy. *Bull. Soc. franç. de dermat. et sypb., Par.*, July, 1924, No. 7, R.S., 67–69.

The following case of lichen planus successfully treated with the roentgen ray is given: a woman aged sixty-four, had been suffering from acute lichen planus for two weeks before seeking medical aid, during which time the condition had become generalized over the limbs and trunk. The papules were large and numerous, and in many places confluent; the eruption had become so intense and widespread that even the palms of the hands and the soles of the feet were affected. The itching was of only moderate intensity. Because of the very apparent relation of the nervous system to this condition, the medulla was treated with the roentgen ray, as was also the vertebral column from the first dorsal vertebra to the fifth lumbar, on January 17 and 20. These regions received 4 H filtered through 5 mm. alumnium. The results were conclusive, for by the tenth day after the treatments the lesions began to turn white and at the same time the itching decreased. A month later, all the lesions had entirely disappeared; the cure of this peculiar condition was complete. Although the writer is cautious not to claim this treatment to be advantageous of this condition, in all cases, he nevertheless is emphatic in his conviction that the cure reported was due entirely to the roentgen ray.

PAYENNEVILLE, M. A case of multiple osseous sporotrichosis with spina ventosa simulating tuberculosis in a child. *Bull. Soc. franç. de dermat. et sypb., Par.*, March, 1924, No. 3, 153–160.

A case of sporotrichosis is reported in detail in which the clinical manifestations resembled both tuberculosis and syphilis. A child, three years old, presented gummatous lesions of one foot, one leg, both hands and one fore-arm. The first diagnosis was tuberculosis of the skin; suspecting syphilis also, Wassermann tests were made of the child and its mother, both being negative. In addition, conjunctivitis analogous to that found in tuberculosis of the skin of the face was noted. With the exception of the ulceration on the leg, all the other cutaneous lesions corresponded with the osseous lesions noted in the roentgenograms. Even these evidences of periostitic hypertrophy were similar to that found in tuberculosis of the bone, and syphilis. Treatment with arsenic was found to be only slightly beneficial. A guinea pig was inoculated with material from the lesions and developed inflammation of the testes, and paraplegia, but no evidences of tuberculosis. The pus from the inflamed testes was cultured on maltose agar and a pure culture of sporotricha was isolated. The arsenic treatment was then stopped and potassium iodide substituted, this being given in increasing doses up to 2 grams. The ulcera-

tions were also dressed with iodine-iodide solution (Gram's iodine solution). This treatment was followed rapidly by reduced swelling of the ulcerated tissue, and general improved condition of the patient. Complete cure resulted from continued treatment with potassium iodide and the Gram's solution. The accuracy of this diagnosis, together with the ease with which cure was effected, is most important in cases which do not respond to the usual treatments for the analogous conditions.

REYN, AXEL. Roentgen and light treatment of tuberculous glands. *Acta radiol., Stockholm*, Dec. 31, 1924, iii, 455–485.

The combination of light bath and roentgen-ray treatment brings about a much quicker result than the light bath alone, but all risk to the patients undergoing roentgen therapy must be avoided. Only small, carefully filtered doses, 3 to 5 H through 4 to 5 mm. Al, ought to be employed. Long intervals of about five weeks should be allowed between treatments, and they must not be repeated too often.

The results show that artificial light in the form of chemical light baths (the carbon arc is much superior to the mercury vapor arc in therapeutic effects) is much better than roentgen rays, for 98 per cent of all the patients treated with light baths were completely cured; while roentgen therapy gave only 40 per cent cures. Finsen therapy as opposed to roentgen therapy has no harmful effect and at the same time exerts a beneficial influence on the whole organism.

The conclusions are based upon 553 cases of tuberculous glands treated from 1910 to 1921.

MISCELLANEOUS

HAXTHAUSEN, H. Some further investigations into the optical characters of the lupus nodules and the bearing of these characters on the Finsen treatment. *Acta radiol., Stockholm*, Dec. 31, 1924, iii, 494–501.

Previous experiments had demonstrated qualitatively that lupous tissue was more transparent to Finsen rays than the normal skin. The present investigation involved the quantitative measurement with special regard to the chemically active rays. Using tissue about 2 mm. thick in these tests it was found that the most effective Finsen rays penetrated the lupous tissue in quantities 2 to 6 times as great as that passing through normal skin of the same thickness.

These observations furnish an explanation of the efficacy of local phototherapeutic treatment in lupus vulgaris. In the diseased area, the rays penetrate more readily and more deeply, thus exerting their beneficial effect.

HUDSON, J. C. Precision *x*-ray spectrometers. *J. Optical Soc. Am.* (*etc.*), September, 1924, ix, 259–301.

One type of instrument makes use of the ionizing effect of the rays and the other of the effect on a photographic plate. In the former the rays reflected from the crystal planes are directed into an ionization chamber generally filled with a heavy gas, and the relative amount of ionization produced is determined by an electrometer or an electroscope. By plotting the ionization currents against angular displacements of the crystal the position of the line may be determined. This is the method first used by the Braggs and in the hands of Professor Duane it has attained a high degree of accuracy.

In the photographic method the reflected ray is received directly on a photographic plate as a slightly curved line and its position may be readily determined. This method has been highly developed by the work of Professor Siegbahn and his students.

The essential physical features of each of these two types of roentgen-ray spectrometer are described and the significance of the results obtained discussed. The ionization spectrometer as developed by Duane has several distinct advantages over the spectrometers making use of the photographic effect. By proper arrangement of the slits, source and ionization chamber many of the errors usually present in the measurements of the angle are eliminated, and the accuracy of the wave length measurements depends solely on the accuracy with which the circular scale can be read. This spectrometer is especially suited for absorption measurements, for besides determining the critical absorption wave lengths the magnitude of the absorption may also be estimated.

The electrometer used for measuring the relative ionization is ordinarily of the Curie type with a sensitiveness of 4 meters per volt for a scale distant 3 meters. It is placed on a stand immediately above the spectrometer and the connecting wire between the ionization chamber and the electrometer is embedded in paraffin and shielded by earthed brass tubes. The electrometer itself is shielded by lead plates one centimeter thick.

A compilation has been made of all the important data on emission wave lengths and critical absorption wave lengths of the different elements and these are presented in a series of tables.

JAEGER, ROBERT. The standardization and control of roentgen dosimeters. *Klin. Wchnschr.*, Nov. 25, 1924, iii, 2191–2193.

A description is given of the principles and application of the Siemens roentgen dosimeter. In this equipment use is made of uranium oxide which was suggested by Behnken as a standard for comparison. The preparation is suitably fixed in a chamber, which can be attached to the dose measuring device to give a definite reading upon the latter. In effect, it represents an artificial ionization current of known and unchangeable magnitude under ordinary conditions of operation. The quantity of uranium oxide utilized is such that its ionization current corresponds to that produced in the small Friedrich chamber under normal conditions of operation, that is approximately 3×10^{-10} amperes. After the dosimeter has been standardized, the standard is disconnected, and the ionization chamber is connected for use in actual measurements.

A nomogram is presented for converting the dosimeter readings as obtained from the uranium oxide standard or from the measured roentgen radiation into terms of the ionization current in amperes.

KOLODNY, ANATOLE. A contribution to the knowledge of pathogenesis of skeletal tuberculosis. *J. Bone & Joint Surg.*, January, 1925, vii, 53–69.

Why do we seldom, if ever, find a primary focus of tuberculosis in the external or posterior aspect of the head of the humerus, of the subtrochanteric fossa of the neck of the femur or of the posterior aspect of the vertebral body, while the sulcus bicipitis humeri, the lower angle of the head of the femur, and the anterior aspect of the vertebral body are the most frequent seat of the primary focus? If the hematogenous-embolic theory is valid, then we should find some anatomic facts which distinguish these most frequent seats of the primary foci. The embolic theory, as suggested by Koenig explains that the tubercle bacillus brought in by the blood stream, stops at a narrowing or a blind ending of the capillary and results in the formation of a tubercle; and the capillaries of the epiphyseal, metaphyseal and diaphyseal blood systems in young individuals do not anastomose.

A study is reported upon the spine, hip, knee, shoulder and costal cartilage, since these regions include about 87 per cent of all cases of tuberculosis of the bones and joints. The study was made by injection with metallic salts followed by roentgenography, by injection with stains, followed by clearing of the bone and by microscopic serial sections. Thus, in the case of a vertebral body together with its intervertebral disc, three distinct bood supply regions may be identified. The intervertebral disc does not contain any blood channels. The epiphysis of the vertebra shows blood vessels extending from the main blood vessels of the vertebral body. No independent blood vessels could be found in young individuals. The main nucleus of the vertebral body is supplied largely by independent vessels entering into it from beneath the anterior longitudinal ligament. This type of blood supply is met with all through the spine, and it can be seen that there is a parallelism between the frequency with which a certain region is primarily involved in tuberculosis and the richness of the blood supply of the respective region. A similar parallelism between the frequency with which certain skeletal regions are affected and their blood supply is demonstrated in the anatomy of the shoulder, the knee, the hip and the costal cartilage.

The anatomic facts here demonstrated furnish ample support for the embolic theory of the pathogenesis of bone tuberculosis. When the blood supply is richer, other features being equal, there is greater possibility of tuberculous involvement and hence the primary focus in these regions is more frequent. A study of the vascularization of the costal cartilages proves that tuberculous foci in these regions can often be of primary and not of secondary nature. The above considerations are entirely independent of certain other aspects of the causation of tuberculosis of the skeleton such as the effects of strain and stress and extraordinary injuries.

KRISER, A. Results with the Wirz method of removing telangiectasis following roentgen therapy. *Wien. klin. Wchnschr.*, Oct. 9, 1924, xxxvii, 1068–1069.

This method has been found to give satisfactory results. The procedure consists in first rendering the affected portion of the skin insensitive to the subsequent electrocoagulation. This anesthesia is produced iontophoretically. The electrode consists of a lead plate 0.5 mm. thick and about 6 sq. cm. in area with edges rounded off. Between this plate and the skin is placed 3 to 5 layers of gauze which must be absolutely free of acid and alkali. The gauze is moistened with several drops of a cocain-adrenalin mixture and the electrode is pressed uniformly over the affected surface avoiding metallic contact with the skin. The indifferent electrode consists of the usual cuff fastened with bandage, the anesthetic solution is dissociated from the anode, and 4 to 10 ma. in 5 to 8 minutes suffices to produce the local anesthesia.

This procedure, besides anesthetising the patient, also causes a contraction of the normal capillaries supplying the affected area so that the telangiectatic vessels stand out clearly.

The electrocoagulation needle is then applied under good illumination, care being taken to make the contact only momentarily and only once at a sitting in any particular spot. Thus, in the case of very much dilated vessels, electrocoagulation is repeated after a period of about 14 days until the whole affected vessel is eliminated.

The procedure requires careful technique and great patience, but in mild cases it results in complete cosmetic success and in severe cases in considerable improvement.

MARXER, O. A. Prolonged life for the Coolidge tube. *Brit. J. Radiol., (B.A.R.P. Section)*, March, 1924, xxix, 103–105.

The tendency in Coolidge tubes to spark toward the adjacent metal parts of the tube boxes, holders and diaphragm is eliminated by the interposition of a sheet of mica. In the more recently constructed over-all tube box heavily protected for treatment purposes, there is no aperture in the front panel which consists of wood one inch thick. In such a box no sparking occurs and no mica is necessary.

The first sign of puncture of the tube is a small half-moon crack in the glass support of the cathode on the edge of the steel cuff. The next is the puncture of the bulb in that neighborhood. This tendency is remedied by wrapping the sleeves in mica tightly and fastening them by means of strapping. Sheets of mica 3 inches square are then added to give further protection by increasing the spark distance between bulb and metal.

MEMMESHEIMER, ALOIS. The hydrogen ion concentration of skin surfaces. *Klin. Wchnschr.*, Nov. 11, 1924, iii, 2102.

By means of rough color comparison of indicators, the pH values of the healthy intact skin surface in over 100 cases were found to lie between 5.2 and 5.8. These values were also the same in extensive skin diseases such as psoriasis, universal eczema and toxic eczema, an unexpected observation.

A study was made of the effect of roentgen rays of the ordinary surface dose. It was necessary, of course, to make measurements upon the irradiated skin which was free from medicinal treatment, such as salves, etc. It was found in a majority of cases that there was a definite shift of the hydrogen ion concentration to the alkaline side in the irradiated surfaces as compared with the unexposed surfaces upon the same individual. This effect was most evident approximately twenty-four hours after irradiation.

MENVILLE, LEON J. Observation of the effect of *x*-ray and radium upon the malarial parasite *in vitro*. *Radiology*, November, 1924, iii, 399–401.

Cultures of *Plasmodium malariae* in glucose blood medium were exposed to roentgen and radium radiation to determine if there was a direct killing action of the rays upon the organisms. The technique employed in these experiments was such as to permit the culture to receive roentgen-ray energy of varying intensities beginning with a mild dose and gradually increasing until the destructive dose was reached. The mild dose was employed to ascertain if the parasites were influenced in their growth and development. The very intense dose was employed in an attempt to destroy the parasites. A destructive dose of radium was applied in the form of 50 mg. for 17 hours filtered through 1 mm. silver and brass.

The observations disclosed that there was no demonstrable direct killing effect exerted by either type of radiation upon the malarial parasite under the conditions of the experiment. These results obtained *in vitro* may not apply to the situation *in vivo*. It is possible that the application of radiation to the spleen of an infected human case may be accompanied by contributory phenomena such as enzyme or lysin production that might affect the parasites.

NEUDA, PAUL. The treatment of general roentgen injury (so-called roentgen cachexia). *Therap. d. Gegenw.*, September, 1924, lxv, 411–413.

The analogy to other conditions producing protein decomposition products, such as burns and nephritis, in which there is a great outpouring of sodium chloride is stressed as sufficient to explain the pathogenesis of roentgen cachexia. This fact would indicate that a chloride enrichment prior to roentgen treatment should be a useful procedure. The author administers 3 gm. of sodium chloride three times on the day preceding irradiation and 10 gm. more on the morning of treatment. This raises the salt level and has been found usually to prevent severe general roentgen injury. It is pointed out that prophylactic salt treatment probably has a different mode of action from the salt that is injected intravenously after irradiation. In the latter case the action seems primarily due to the hypertonic solution used, because injections of 10 to 25 per cent glucose produce the same results.

PLAUT, HANS F. Roentgen studies of bone nucleus formation in rachitis. *Ztscbr. f. Kinderb., Berl.*, 1924, xxxviii, 540–556.

Roentgenographically, bone nuclei appear to be laid down without delay in mild rachitis of infants. So long as a moderate or severe rachitis is present in the florid stage the roentgen picture discloses no new bone nuclei. The latter are actually laid down as is demonstrated histologically, but owing to the fact that calcification is deficient, these new nuclei remain invisible until repair sets in and calcium is laid down. Consequently this absence is only apparent and due to a limitation in the roentgenologic method of examination.

This characteristic of apparent delay in ossification may also be demonstrated roentgenographically if the examination is made after the recovery process has set in. Under such circumstances, the roentgenogram taken after a moderate or severe rachitis shows in a few days bone nuclei of a size that indicates their previous existence for months. In very acute rachitis, bone nuclei which could previously be clearly discerned in the roentgen picture may become invisible owing to loss of calcium. Only where acute rachitis is complicated by a severe disturbance of the general bodily development is there evident an actual delay in the development of the bone nuclei. This occurred in about half of the cases observed. In these, there appear very much delayed punctiform centers of calcification in contradistinction to the sudden appearance of the large bone nuclei described above.

POHLE, ERNST A. Measurements of the quality and quantity of *x*-rays in deep therapy. *Radiology*, December, 1924, iii, 504–507.

Measurements of the quality and quantity of roentgen rays using an American transformer (Kelley-Koett), a German A E G Coolidge tube and a Winawer-Back standardized electroscope were made to determine the absorption of aluminum as an exact measuring material for short wave length radiation. The absorption values for water corresponding to those for aluminum were taken from the works of Lorenz and Rajewski. Each test was made at 2, 3 and 4 ma., and the effective wave length according to the method of Duane was also determined.

The results show that the values for μ_{H_2O} under the arrangements used in the test vary quite a bit, despite efforts to avoid all errors. The figures agree much better for the effective wave lengths, the constancy of which proves that there is no great difference in the quality of the roentgen-ray beam at various amperages. Tests using the same voltage and filter and different milliamperages showed that an increase in intensity with increasing amperage did not increase arithmetically. That is, it is not correct to calculate the erythema time for 4 ma. as one-half the exposure known to produce erythema dose at 2 ma. The only exact procedure is to make the actual tests on the tube.

ROGATZ, JULIUS. Roentgenologic studies on the peristaltic function of the stomach in infancy and its importance in the causation of habitual vomiting. *Ztscbr. f. Kinderb., Berl.*, 1924, xxxviii, 540–556.

Numerous comparative observations were made on a number of infants both roentgenoscopically and roentgenographically, the children being held in a vertical position during the various examinations.

When the usual fluid diet was fed the infant's stomach took on one of two characteristic shapes. In the first type, the stomach is pear-shaped and lying horizontally, and contains a large air bubble. The second type is ellipsoidal in shape and contains a fairly large air space. One or the other type appeared to remain constant in any particular child examined so long as the diet was fluid.

On the other hand, when a thick vegetable gruel was fed the stomach took on an entirely different shape. Attention is directed to the fact that the usual cereal gruel, though it may appear of high consistency will become fluid in the stomach under the influence of admixed saliva and body temperature. The thick vegetable (potato) gruels, on the other hand, were found to retain their consistency in the stomach. When this latter form of diet was fed, both types of stomach above described took on a decidedly smaller, usually spherical shape with very small air space. This alteration is due to the development of peristole.

The mechanism whereby peristalsis hinders vomiting is not altogether clear. It seems that the vomiting may be laid to abnormal conditions of tonus in the gastric musculature. By peristaltic action the gastric contents are worked gradually toward the pyloric region. This is evidently easily accomplished in the case of a thick gruel, and rather difficult of accomplishment in the case of liquid stomach contents.